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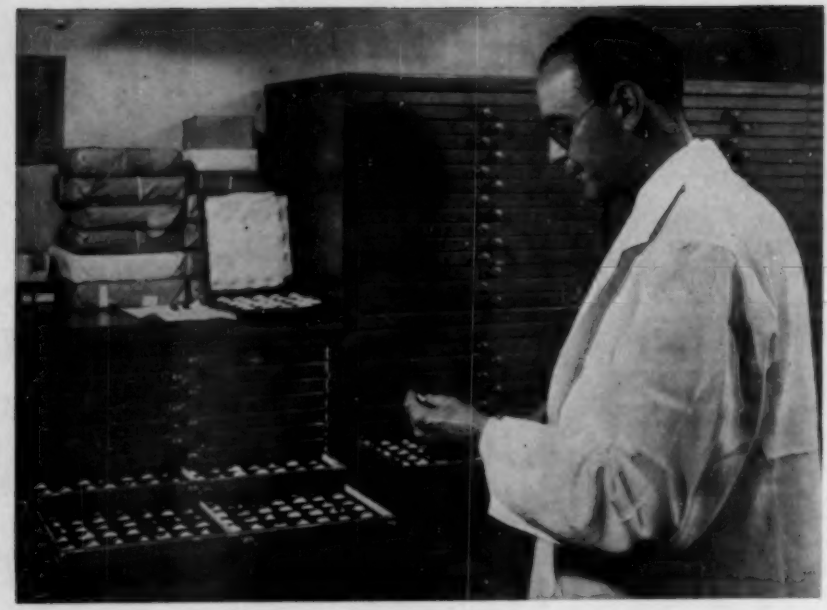
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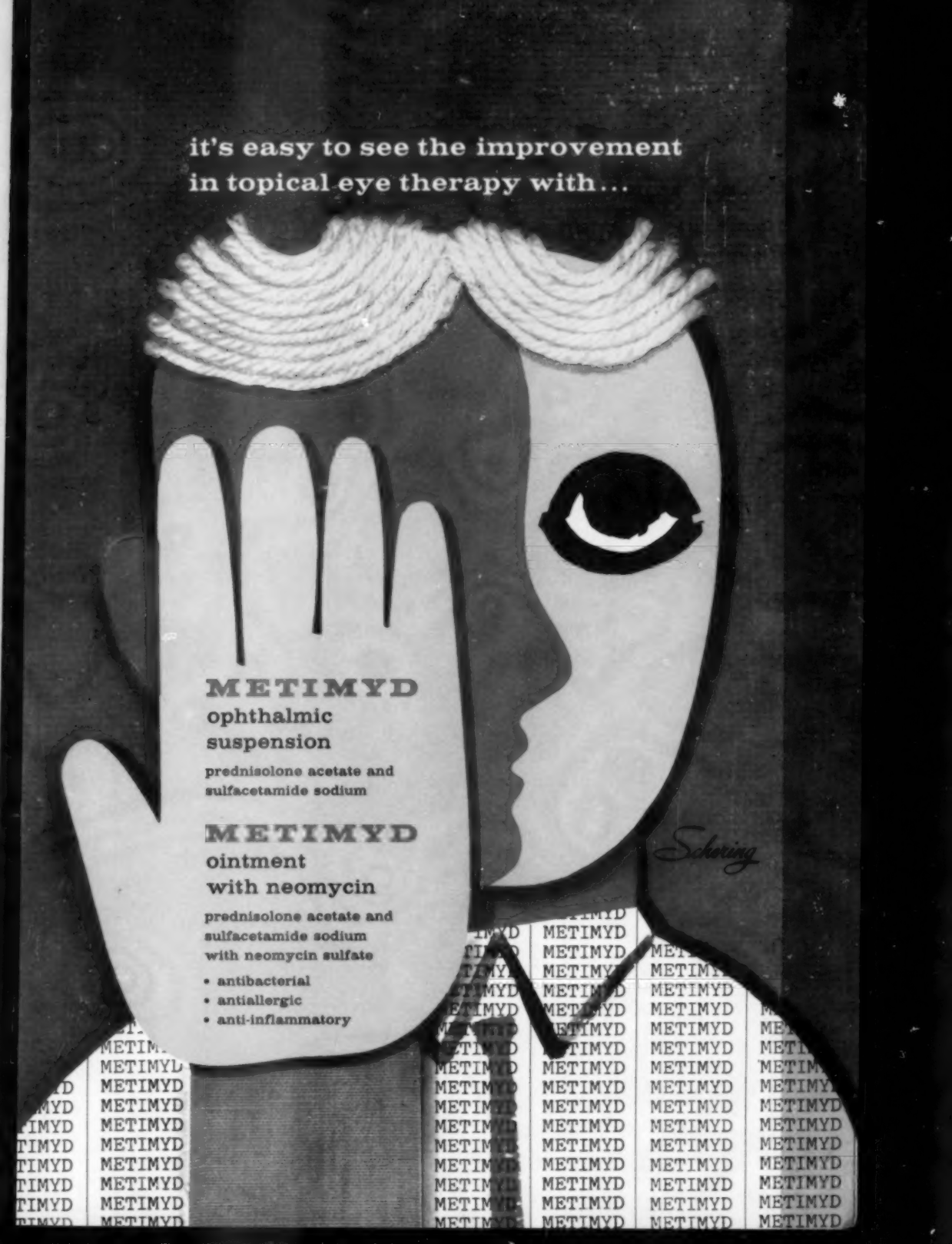
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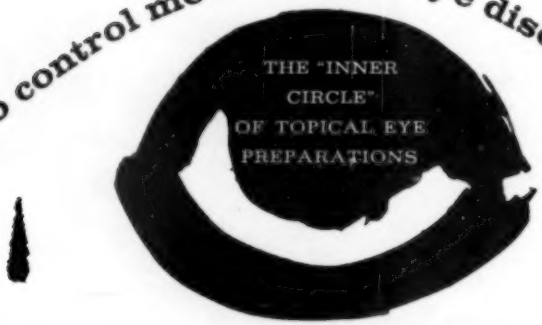
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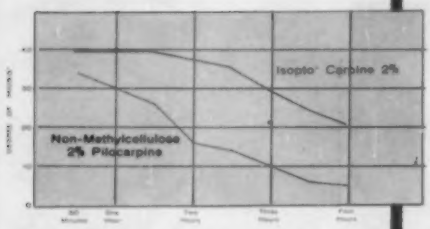
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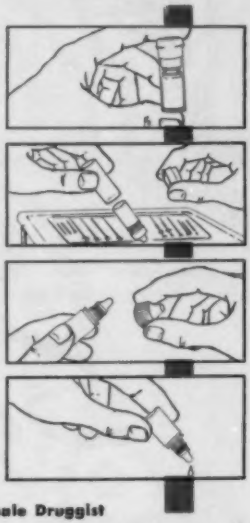
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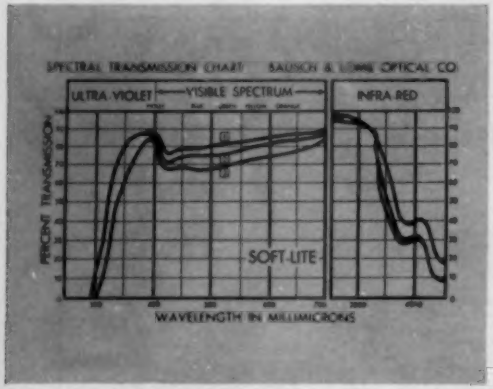
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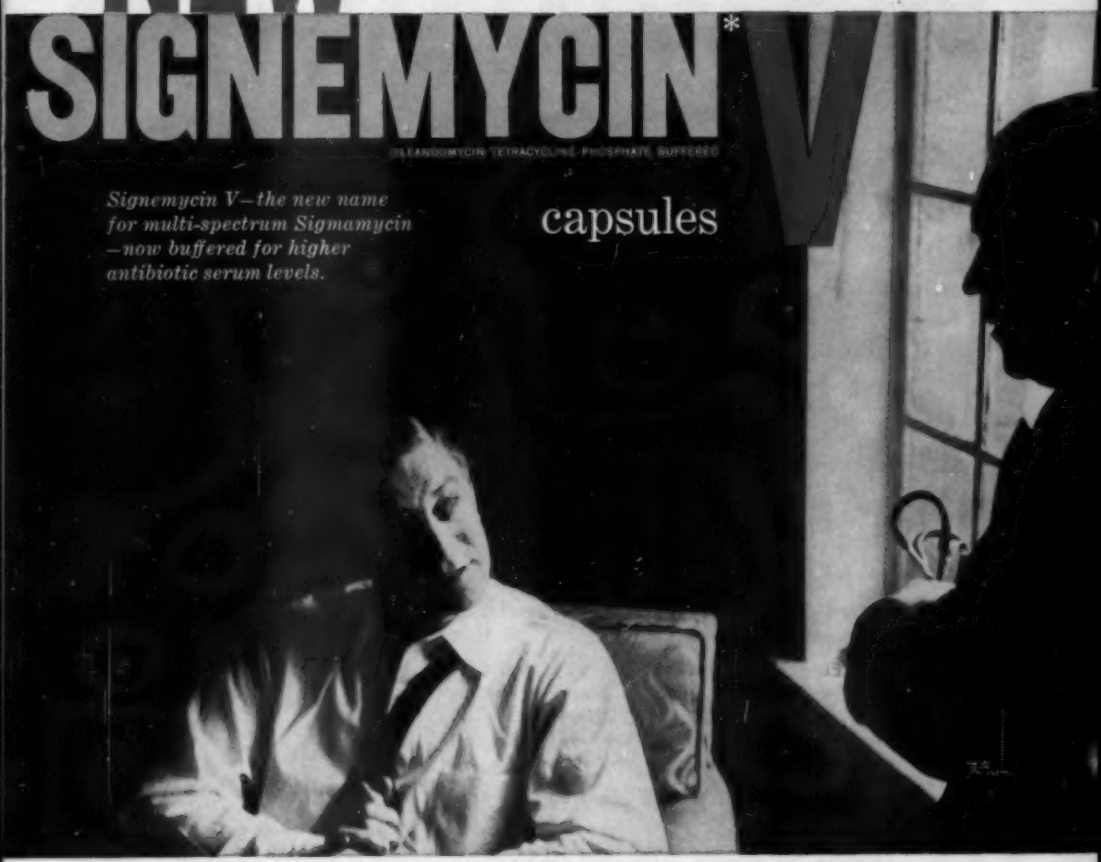
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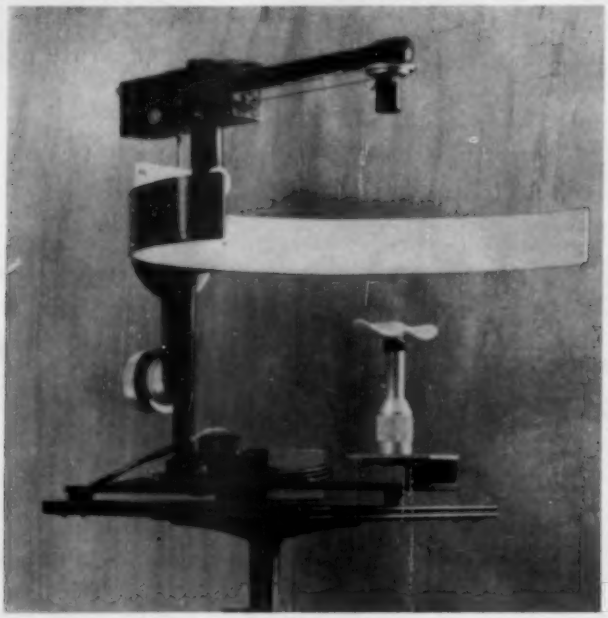


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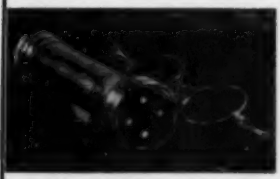
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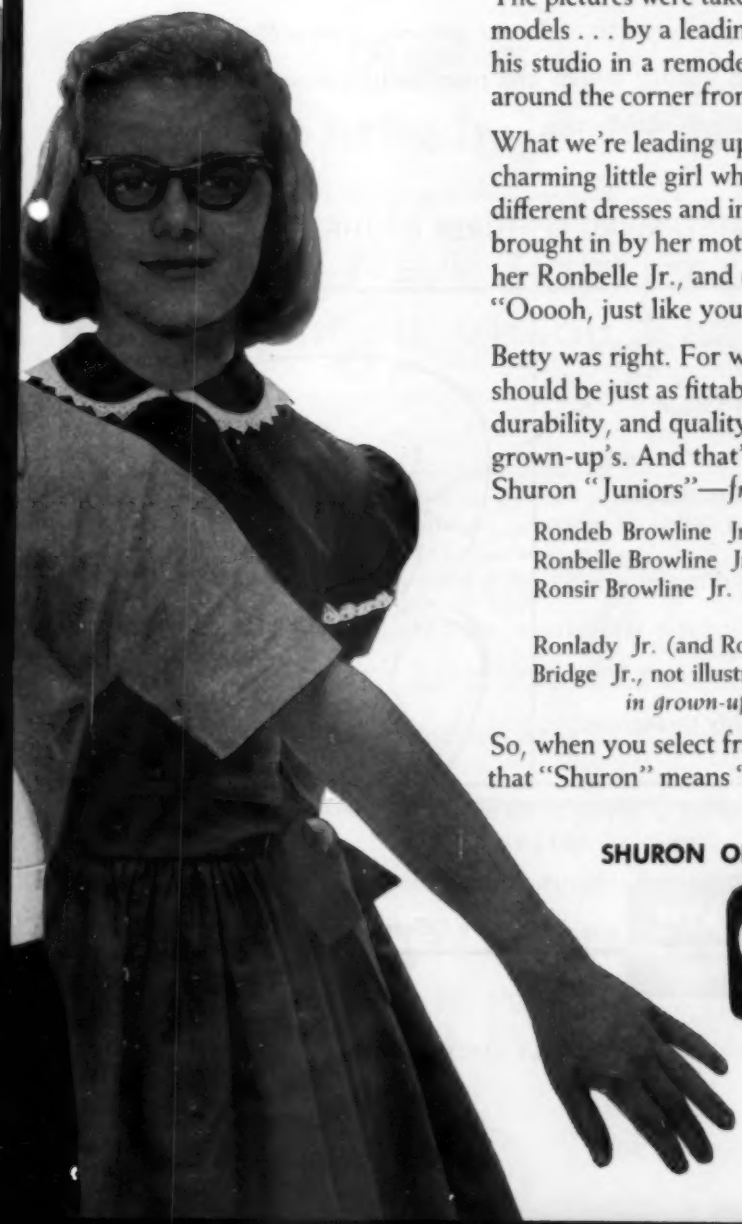
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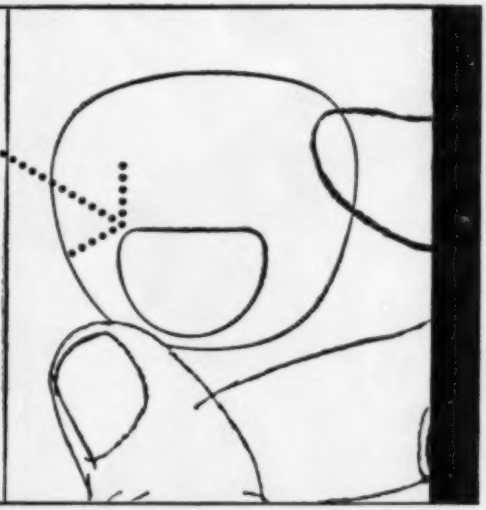
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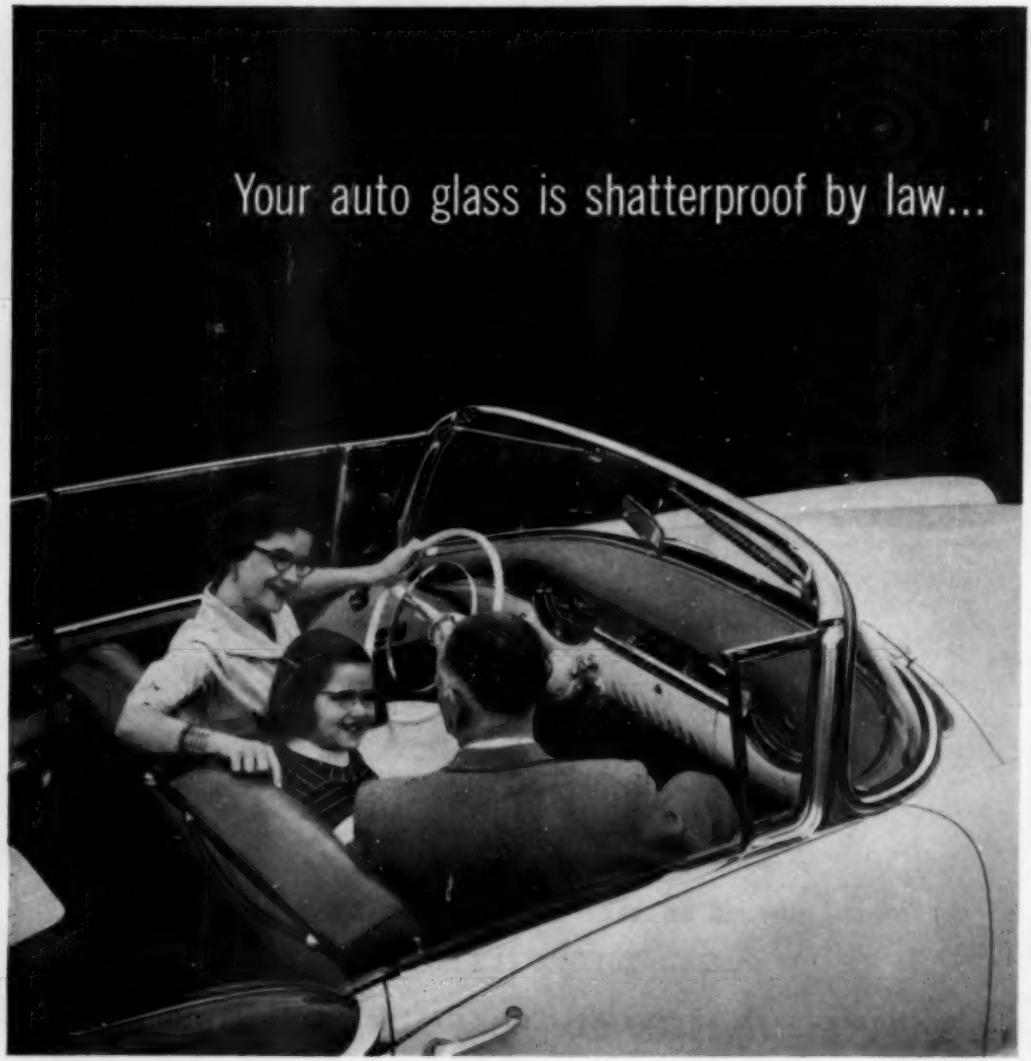
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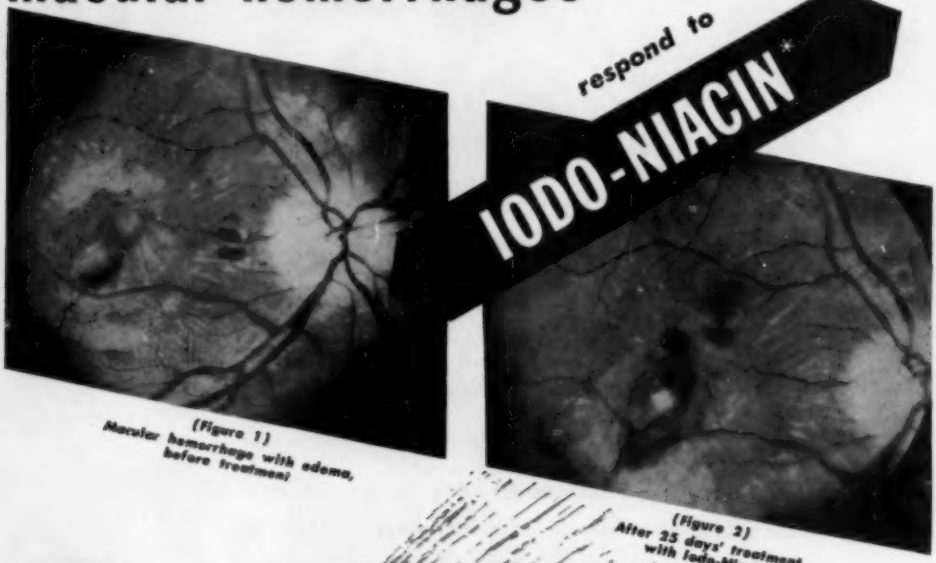
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macular hemorrhages



(Figure 1)
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(Figure 2)
After 25 days' treatment with Iodo-Niacin



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1. *Am. J. Ophth.* 42:771, 1956.
2. *Am. J. Digest Dis.* 22:5, 1955.
3. *Med. Times* 84:741, 1956.
4. *Cecil's Textbook of Medicine*, 7th ed., 1947, p. 1598.

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☆ ☆ ☆

In this brief report it has been possible only to touch on some of the steps we are taking here at Titmus Optical Company to meet the challenge of providing better eye care to the large segment of our population who need it . . . and some of the reasons we feel that, in this never-ending search for improved ophthalmic materials and techniques, "The best is yet to come."



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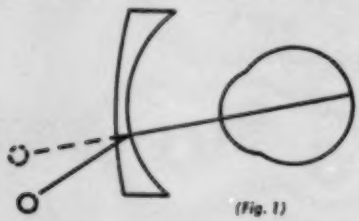
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BIFOCALS FOR MYOPES

It is an established fact that myopes have a lot of trouble becoming adjusted to bifocals. Hyperopes usually have very little trouble, and people wearing cataract bifocals no trouble at all if the lenses are well designed and if the segments are properly placed.

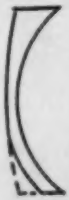
The reason that myopic bifocals are troublesome lies in the fact that through the segments, even of the best available bifocals, base down prism is encountered.



(Fig. 1)

This base down prism makes objects appear farther away and higher than they really are. See figure 1. The myope, before bifocals fixed his line of vision through a point 8 mm. below the distance center, invariably tipped his head and looked through a point near the distance center, thus avoiding prismatic effect. The hyperope on the other hand is not troubled by the base up prism he encounters and has little or no difficulty with bifocals.

From the foregoing it would seem that if the base prism found in the segments of myopic bifocals could be neutralized, the problem would be solved. We have found this to be true. We have also found that the only practical way to accomplish this neutralization is by "slabbing off" the proper amount from the bifocal segments. See figure 2.



(Fig. 2)

If we take a case requiring O.U.—6.00 with a +2.00 add made up in a small segment bifocal, we would "slab off" 4.8 degrees of prism base up from both segments. ($6 \times .8 = 4.8$) that is, the distance correction through the 90th meridian times .8, the distance in cms. from distance center to reading point, equals the amount of base down prism that must be neutralized.

A case requiring O.D.—5.00 and O.S.—7.00 would have a 4 degree prism base up slab off on the right and a 5.6 degree prism base up slab off on the left lens.

In this case, two things would have been accomplished: the annoying base down prism would have been neutralized and the induced vertical imbalance corrected.

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SERIES 3 · VOLUME 44 · NUMBER 2 · AUGUST, 1957

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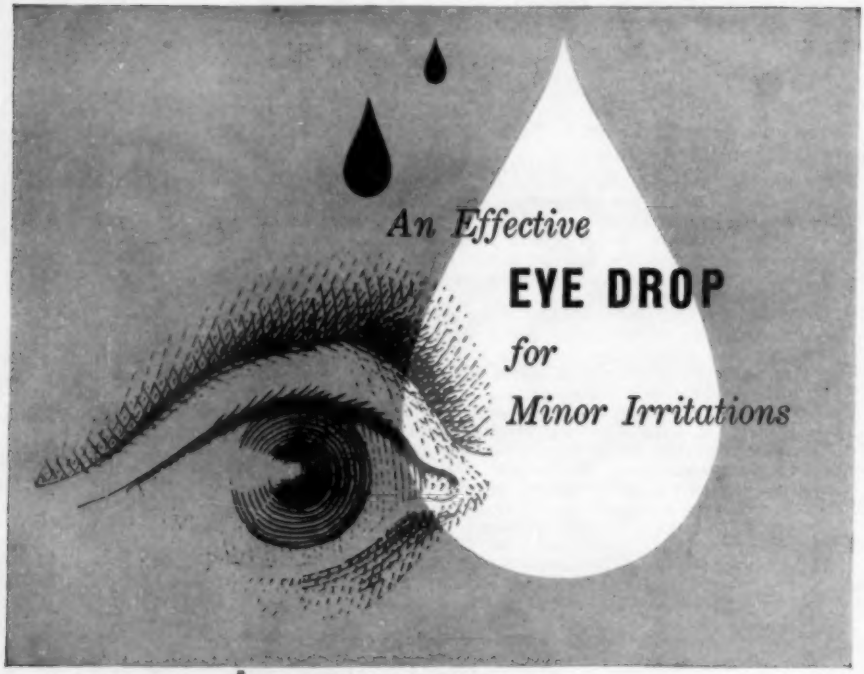
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ABSTRACTS

Vegetative physiology, biochemistry, pharmacology, toxicology; Physiologic optics, refraction, color vision; Diagnosis and therapy; Ocular motility; Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension; Crystalline lens; Retina and vitreous; Optic nerve and chiasm; Neuro-ophthalmology; Eyeball, orbit, sinuses; Eyelids, lacrimal apparatus; Tumors; Injuries; Systemic disease and parasites: Congenital deformities, heredity; Hygiene, sociology, education, and history 283

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THE LENS EPITHELIUM IN THE PATHOGENESIS OF CATARACT*

THE XIII EDWARD JACKSON MEMORIAL LECTURE

LUDWIG VON SALLMANN, M.D.
Bethesda, Maryland

May I say, first of all, what an honor it is for me to be called upon to give a lecture which commemorates one of the great American ophthalmologists. Homage has been paid to the extraordinary qualities of Edward Jackson in the past by most competent speakers, who had known him and his work. Lavish has been their praise and acknowledgment of the man as investigator, physician, and teacher, as well as of his contributions to our specialty. I am sorry that I had no opportunity to meet Dr. Jackson personally, but I can add to what has been said before that his name was held in high esteem across the ocean in ophthalmologic circles, especially in those eye clinics where refraction problems of a higher order were under study.

My paper today is concerned with a problem almost a century old. What part the lens epithelium plays in the development of cataract, particularly in development of the senile variety has been the topic of repeated controversy between outstanding ophthalmologists through that century but no final agreement has been reached.

The amazing unfolding of issues dealing with the biochemistry and the metabolism of the lens in the last few decades has not advanced a basis for definite concepts on pathogenesis of cataract, nor have the new studies of submicroscopic lens structures had, as yet, any bearing on the problem. Thus, at the present state of our technical knowledge, examination with the light microscope on a cellular level best lends itself to the attack of pending questions.

In the current work, two lines of approach were selected. In one extensive series of experiments, the effects of one standard dose of an agent injurious to the lens were compared among seven species of laboratory animals. In the second part, the varying sequelae produced by five cataractogenic agents were contrasted in one species. The observations covered prolonged periods but pertained predominantly to those stages which promised insight into what could be termed the early dynamics of pathogenetic events. Information on morphologic detail was obtained by in vivo examination with the slitlamp, by microscopic studies on whole mounts of epithelial preparations, and on histologic sections of the lens. About 1,000 lenses were analyzed in this fashion. For obvious reasons, the manifold results derived from observations on so great a mass of material cannot be incorporated in this paper but will require subsequent detailed reporting.

Before the data of the two main groups of investigations are reviewed, it should be stressed that throughout the study, emphasis was placed on such experimentally induced lens changes as permitted a quantitative breakdown of the results. Alterations of cell division and emergence of cells with signs of nuclear fragmentation caused by the various agents proved suitable for this purpose, whereas other signs of damage, such as

* From the Ophthalmology Branch National Institute of Neurological Diseases and Blindness, National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare. Presented at the 61st annual session of the American Academy of Ophthalmology and Otolaryngology, October, 1956, Chicago.

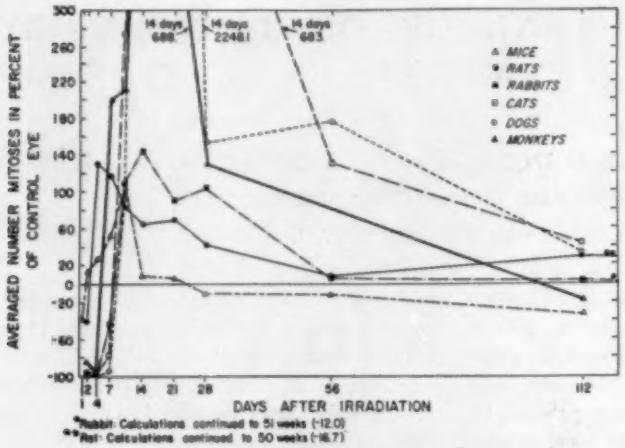


Fig. 1 (von Sallmann). Effect of 1,000 r X rays on the mitotic rate of the lens epithelium of mice, rats, rabbits, cats, dogs, and monkeys.

proliferation and degeneration of nucleated elements and the occurrence of hydropic and other destructive lesions of the lens fibers, allowed only descriptive analysis. This is true also of the biomicroscopic observations.

Roentgen irradiation with isodoses was the one cataractogenic agent applied to seven species of laboratory animals. Figure 1 depicts the effect of a locally used dose of 1,000 r penetrating X rays on cell division in the lens epithelium of mice, rats, rabbits, cats, dogs, and monkeys. Guinea pigs could not be included. The average number of dividing cells expressed in percentages of the figures obtained from the untreated control eyes is plotted against the time in days after exposure of the eyes to the X-ray beam, with the time scale limited to 16 weeks. Evidently, in the studied animal species, cell division initially appeared depressed or completely inhibited in all instances, but the extent of this depression varied, as well as the period of time before an excessive increase of this cell function took place. The overshooting phenomenon reached the highest peak in dogs and cats; in fact, here the maxima cannot be shown in the graph.

Another experimentally produced early effect—one of greater pathogenetic importance, I believe—is nuclear fragmentation, or extrusion of chromatin material from the cell. Figure 2 discloses a wide variation

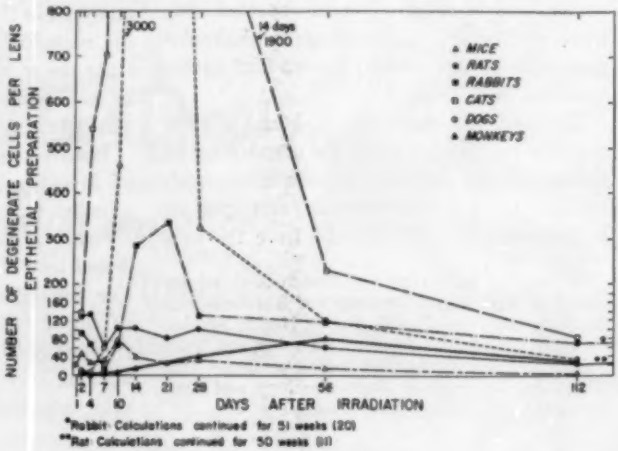


Fig. 2 (von Sallmann). Averaged counts of degenerate cells in whole lens epithelium after irradiation with 1,000 r X rays.

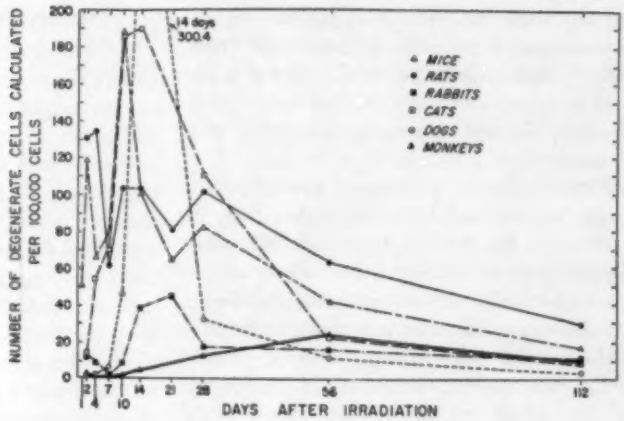


Fig. 3 (von Sallmann). Averaged counts of degenerate cells in lens epithelium after irradiation with 1,000 r X rays calculated for 100,000 cells.

in the development of this change between different species. In this instance the counts of degenerate cells comprise the damaged nuclei of the entire lens epithelium at various times after exposure. Data on injury have more meaning for comparison when they are calculated per units of cells; that is, per 100,000 cells (fig. 3), since the total cell population per lens in the examined species varies greatly with the size of the organ.

Figure 3 conveys the impression of an imposing difference between species in the extent of lesions of the nucleus, similar to the graphs of changes in cell division. Cell nuclei in the lens epithelium of dogs and cats extruded chromatin material at the highest rate, and those of monkeys at the lowest. The effects on the epithelial cells of mice and rats ranged close to those observed in cats. On the other hand, appearance time of the damage, the climb to peak values about two weeks after irradiation, and the decrease of the change within the 16 weeks' period bear out the basic uniformity of the response in the various animal groups.

Not recorded in Figures 1, 2, and 3 were the observations at the one-year interval obtained from examination of rats, rabbits, and guinea pigs. They suggest that the process of nuclear fragmentation induced by exposure of the eye to the 1,000 r of X rays had almost come to an end at this time, but that the lens epithelium had undergone severe pathologic changes of great polymorphism, particularly in the germinative zone and the bow area.

Initial lenticular opacities were noticed in mice, rats, rabbits, and cats three to four months after irradiation, and in guinea pigs after two months. They increased and progressed in mice and rats faster than in other animal groups. In the dog and the monkey, lenses usually remained clear during this period. Histologic studies indicated that displacement of bow nuclei forward and backward and proliferation of epithelial cells from the germinative zone preceded for months the first signs of lens opacification. As a rule, cell proliferation also occurred earlier than swelling and disintegration of lens fibers or the new formation of abnormal nucleated fibers.

All of these changes were widespread in mice, rats, and rabbits, and, in later stages, in guinea pigs; they were minimal or absent in cats, dogs, and monkeys. In dogs and guinea pigs, hydrops of lens fibers was not clearly related to structural changes of the bow nuclei or to proliferation of cells.

The assumption has been made by several investigators[3] that ionizing radiation first injures equatorial cells of the epithelium and that opacification as the final result of the damage originates in lesions of the cell nuclei in the germinative zone. The new observations on dog and cat lens epithelia, which

outstandingly exhibit the phenomenon of extrusion of Feulgen-positive material from the cell nuclei within two weeks after irradiation without subsequent marked cataractous changes, do not necessarily invalidate this concept.

Examination of a series of normal lenses from puppies and kittens revealed that, in contrast to the absence of extruded chromatin in lenses of rabbits a few weeks old, a great number of extruded chromatin globules were dispersed between morphologically normal epithelial cells during the rapid growth phase. These events might be an expression of the effort of the cell to preserve its nucleus-cytoplasm relationship, an explanation that can be applied to the described radiobiologic effect on the epithelium of cats and of dogs.

These changes, then differ from the signs of nuclear fragmentation and extrusion of chromatin globules from the cell in other species; here they frequently institute cell death or permanent injury, as shown in the whole-mount preparations made at later intervals.

Whether the dissociation of pathologic change in the fibers and damage to the cell nuclei in dogs and guinea pigs denotes a qualitative radiobiologic difference of significance is not clear at the present time. Certainly, the demonstrated graphic illustrations of early radiation injury and the short description of pertinent histopathologic changes intimate a quantitative but not qualitative dissimilarity of the responses. Damage to the nuclei of the surface epithelium in the germinative zone, then, appears to give rise to ensuing pathologic change in the fibers in all examined animal groups.

In the second part of the study, the rat served as experimental animal. The effects of the following five cataractogenic agents were compared: tryptophane, galactose, Myleran,® 1,000 r of X rays, and alloxan. In view of the similarity of the lens changes induced by galactose and by alloxan, the latter will not be taken up in this presentation.

Tryptophane deficiency cataract

Twelve litters of Sprague-Dawley rats (males, four animals per litter) were placed on the tryptophane-deficient diet of Totter and Day[5] at the age of three weeks; one animal of each litter was used as control. The experimental rats developed cataractous changes when the deficient diet had been continued five weeks. The body-weight gains decreased rapidly with time, and many animals died before lens changes were detected with the biomicroscope. The weights of the globes also were considerably less than those of the control litter mate. The cataractous changes consisted mostly of small specks and fine nets or silky striations in the anterior cortex and slight diffuse opacities in the posterior cortex. Microscopically, the cells of the surface epithelium and the nuclei of the lens bow appeared normal in morphologic detail and spatial arrangement.

An initial moderate fall of mitotic activity was followed by an equally moderate increase of this function, and at the time when cortical opacities developed, a slow decrease of cell mitosis set in (fig. 4). Obviously, then, in this deficiency state the epithelial cells did not exhibit signs of injury which can be incriminated as cause for the evolution of cataractous changes.

Galactose cataract

Cataract produced by galactose feeding has been thoroughly studied morphologically

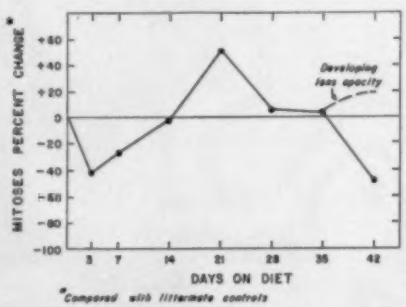


Fig. 4 (von Sallmann). Effect of tryptophane-deficient diet on mitotic rate in the lens epithelium of rats.

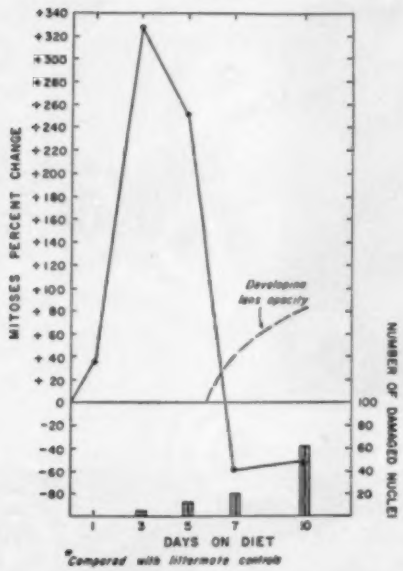


Fig. 5 (von Sallmann). Effect of galactose diet on mitotic rate and extrusion of Feulgen-positive material in the lens epithelium of rats.

and biochemically,[1-3] but the relation of fiber damage to epithelial changes has not been investigated nor reported. The clinical picture of this cataract is well known. In most instances, when young rats are used, it is characterized by the appearance of a complete or interrupted circle of subcapsular vacuoles in the pre-equatorial zone of the lens. More extensive and progressive changes in the cortical layers follow later. In the present observations on Sherman albino rats, the vacuoles and other less prominent changes were noted about five to seven days after feeding was begun.

The behavior of the lens epithelium in regard to cell division and cell degeneration is shown in Figure 5. The number of dividing cells increased within the first three days and fell to normal values when vacuoles were seen biomicroscopically. Few degenerate cells were counted at this time. Their number rose considerably in the following three days when cataractous changes progressed and cell division was depressed.

In histologic sections, proliferation of nucleated elements was lacking at and behind the equator despite pronounced swelling and vacuolation of lens fibers (fig. 6). This is in clear contrast to the radiation-induced histopathologic changes in the lens. Hydrops of the fibers in the equatorial area and their destruction by huge vacuoles coexisted with normal-appearing nuclei of the uninvolved fibers of the bow at the one-week interval (figs. 7 and 8).

One eye was removed at this time for histologic study, and the galactose diet was discontinued. Clinical recovery from the lenticular opacification in the second eye followed. Seven weeks later, architecture of the bow area was restored almost to normal (fig. 9). Although lenses in this stage



Fig. 6 (von Sallmann). Swelling and vacuolation of nucleated lens fibers at the equator seven days after galactose diet was started (×140).

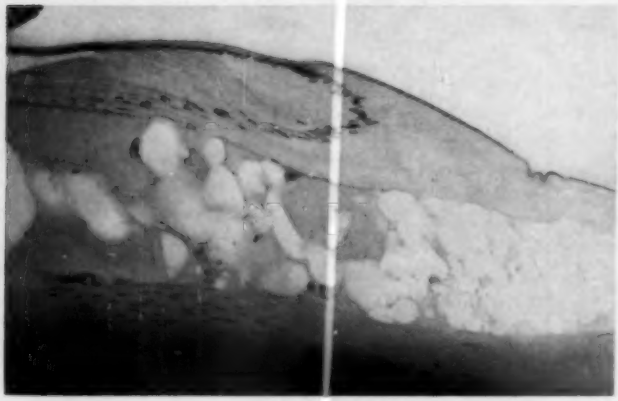


Fig. 7 (von Sallmann). Extensive injury to the lens fibers at the equator 10 days after galactose diet was started (Rat 113, ×95).



Fig. 8 (von Sallmann). Extensive injury to the lens fibers at the equator 10 days after galactose diet was started (Rat 114, ×70).

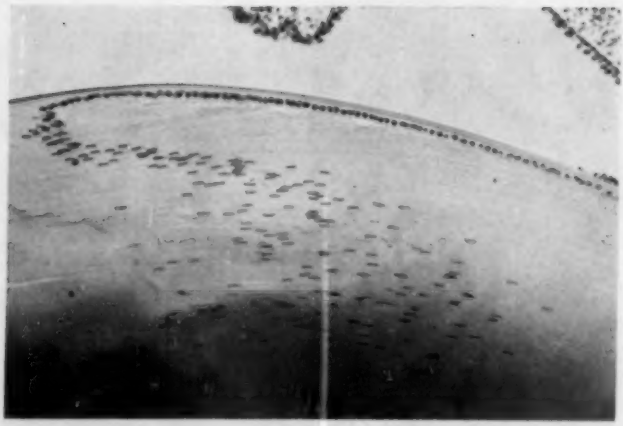


Fig. 9 (von Sallmann). Restoration of region of lens bow in second eye of Rat 113, seven weeks after galactose was discontinued (×140).



Fig. 10 (von Sallmann). Restoration of region of lens bow in second eye of Rat 114, seven weeks after galactose was discontinued (×90).

contained only circumscribed opacities in the deeper layers of the cortex, broad clefts of proteolyzed fibers usually interrupted the histologic picture, as described by Gifford and Bellows[2] (fig. 10).

It can be concluded from the sequence of intra vitam and microscopically observed changes, first, that the variations in the mitotic rates and the low-grade cell degeneration of the lens epithelium are not likely to be causally connected with the extensive vacuolation in the equatorial area and, second, that the severe changes primarily involve the cytoplasm of young fibers.

Myleran® cataract

New information was gained from a systematic study of lens changes produced by feeding young rats small quantities of a sulfonic acid ester known under the proprietary name Myleran.® This compound belongs to the radiomimetic chemotherapeutic drugs; it was found effectual in the treatment of chronic myelogenous leukemia. During chronic toxicity studies on Myleran,® workers at the Wellcome Research Laboratories observed the development of cataract. A preliminary report of the Knapp Laboratory of Columbia University on early histologic changes of the lens was included in the brief description of this cataract by investigators in the Wellcome Laboratories.[4] In the present series, consisting of 72 animals, the initial changes evolved from five to seven weeks after the animals were placed on the diet of Purina fox chow, which contained 15 mg. of Myleran® per kg. White dots in the posterior and anterior lens cortex appeared at the same time, often together with net-shaped or diffuse opacities located in the posterior cortical layers. Occasionally, vacuoles were seen in the periphery of the posterior cortex, and in two instances the cataract near the posterior pole was of the bivalve type.

The composite Figure 11 again illustrates the effect of the cataractogenic agent on cell division and cell degeneration and also indicates the time relationship between these

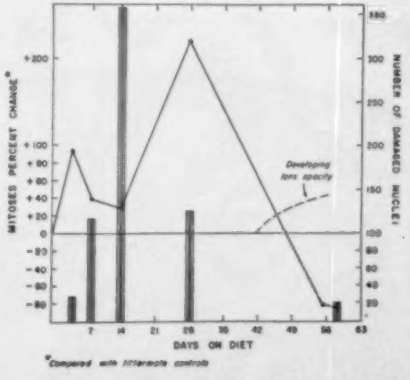


Fig. 11 (von Sallmann). Effect of Myleran® on mitotic rate and extrusion of Feulgen-positive material in the lens epithelium of rats.

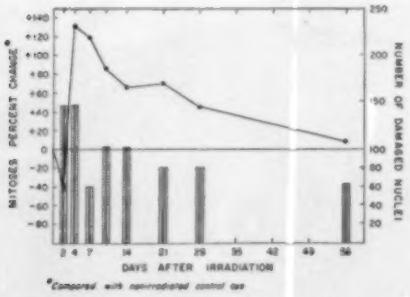


Fig. 12 (von Sallmann). Effect of 1,000 r X rays on mitotic rate and extrusion of Feulgen-positive material in the lens epithelium of rats.

changes and the development of lenticular opacities. Cell division was not depressed. Initially its rate rose for one week, then at two weeks the curve climbed to a second maximum. The activity remained elevated for about six weeks in all, before it decreased below normal levels in the last weeks of the observation period.

Nuclear fragmentation was a prominent feature. The counts of degenerate cells ascended to a very high figure at the end of the two-week period, and incidence of degenerate cells continued to be high in the following two weeks. The typical forms of extrusion of nuclear material, frequently leading to cell death, were combined with a multitude of degenerative signs, such as anisocytosis with giant nuclei and micronuclei, anisochromia, pathologic mitosis, pyknosis, and loss of the normal pattern characteristic of the various zones of the lens epithelium. Thus, among the agents examined in this study, only Myleran® produced cell degeneration which closely resembled that produced by ionizing radiations.

Figure 12 is shown for comparison of lesions produced by 1,000 r of X rays in rats with those induced by Myleran.® Under the experimental conditions, cataractous changes following roentgen irradiation appeared later than eight weeks after exposure. The microscopic examination of the lenses of Myleran®-fed rats, then, confirmed the observation made on irradiated rats with regard to the presence of pronounced cytologic changes long before opacities were recognized with the slitlamp.

In contrast to the radiation-produced lesions, bow nuclei showed only slight displacement backward about seven weeks after induction of the Myleran® diet (fig. 13). At this time, swelling of lens fibers was often conspicuous. The most important difference between these two types of experimental cataract, however, is the hydropic swelling of the distal ends of superficial lens fibers posteriorly in the absence of migrating cells in the cortical layers, in the experiments with Myleran® (fig. 14). This damage appears to be the substrate of the clinically

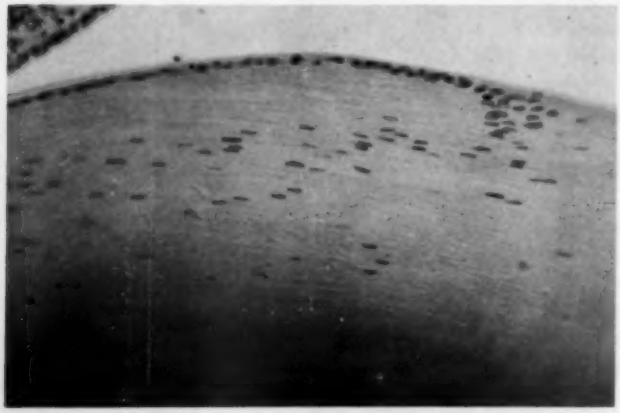


Fig. 13 (von Sallmann). Moderate displacement of bow nuclei seven weeks after Myleran® diet was started (×100).

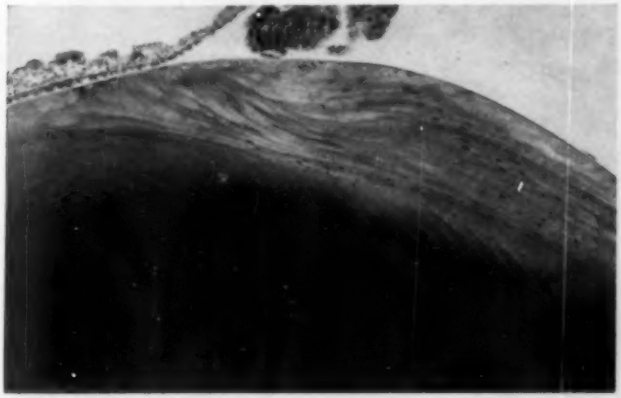


Fig. 14 (von Sallmann). Moderate displacement of bow nuclei and hydrops of equatorial fibers seven weeks after Myleran® diet was started (×80).

seen diffuse opacities around the posterior pole (fig. 15, A and B). Hydropic fibers at the equator affected the architecture of the bow area as they displaced deeply situated normal fibers and disarranged the spatial distribution of the bow nuclei (fig. 16). Degenerative changes in the bow nuclei are shown in Figure 17.

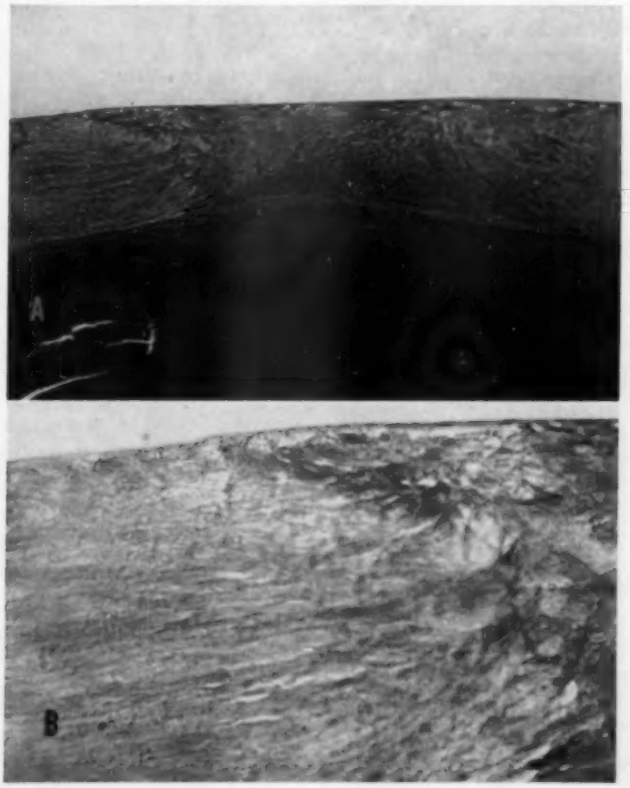


Fig. 15 (von Sallmann). Hydropic swelling of posterior ends of superficial lens fibers in the absence of migration cells seven weeks after Myleran® diet was started: (A) ×100, (B) ×550.

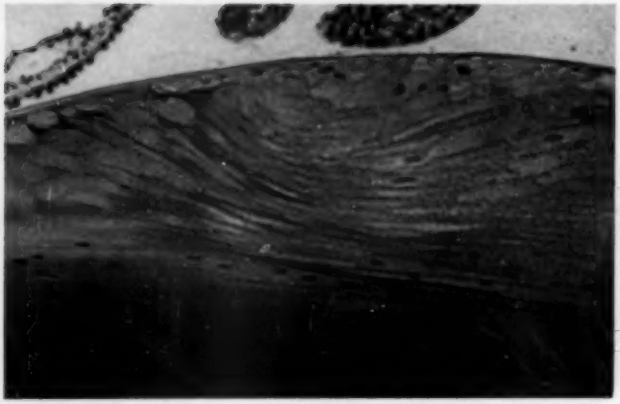


Fig. 16 (von Sallmann). Displacement of deep equatorial fibers by swollen superficial fibers seven weeks after Myleran® diet was started (×140).

The described observations on the rats given Myleran® point to a severe early injury of the lens epithelium and, probably independent of this lesion, to extensive changes in young nucleated lens fibers. Hydropic fiber swelling set in at the equatorial area and, after a short time, led to swelling at the distal ends of the fibers near the posterior pole. The bivalve appearance of the cataract in a few experiments was not connected with migration of damaged epithelial cells, from which, in radiation cataract, freak lens fibers originate.

Comments and Conclusions

It is fully realized that any approach to the cataract problem which pertains to cellular and tissue morphology alone is very incomplete by nature, but at present the succession of experimentally induced lesions in the lens tissue can be followed best by microscopic studies. In this paper a fairly wide survey on cytologic, histologic, and biomicroscopic changes of the injured lens provides certain guidelines relative to cataractogenesis in man.

1. Biologic consequences of X-ray radiation in the lens have been found to be fundamentally similar in the seven studied animal groups, despite great variations in the extent of the lesions. Species with the lowest mitotic activity in the epithelium were slowest in showing damage of tissue elements of the lens. Estimates of cell division

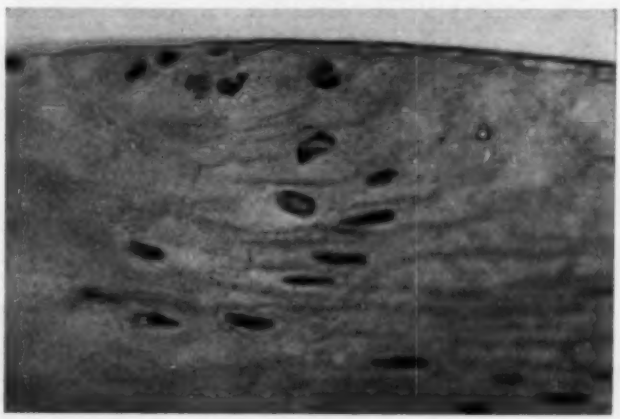


Fig. 17 (von Sallmann). Degeneration of bow nuclei seven weeks after Myleran® diet was started.

in the clear human lens lack accuracy. From one to 10 dividing cells were counted in eight such lenses, but local or general anesthesia or the lapse of time after death of the patient obviously affected the counts. By extrapolation of experimental data, it can be assumed that primary damage to the cell nuclei in the germinative zone and migration of cell elements from this area, or displacement of cell nuclei from the bow, occur also in the irradiated human lens. The innate tendency of this lesion to stay quiescent for long periods and usually to progress at a slow rate are well-known characteristics of radiation cataract of man.

2. Experimental galactose cataract also has its correlate in human lens pathology. Recovery from lens damage in this instance can be explained by the moderate involvement of the cells in the germinative zone and by the transposition of extensively injured fibers to deeper layers by healthy young fibers. The damaged fibers give rise to inconspicuous residual opacities.

3. Myleran® cataract of the human eye has not been reported, but systematic studies on patients treated with the compound for chronic myelogenous leukemia have not been carried out. From the experiments on rats, it is to be expected that such cataracts would not easily regress, although they may be so slow in onset and development that opacities cannot be observed at all during the life span of such patients. Attention should be drawn to this cataract, nevertheless, because its qualities make it well suited for microscopic, histochemical, or metabolic studies.

4. Cataract formation in tryptophane-deficient rats is an example of the development of opacities in lenses with an apparent normal epithelium. Further studies are necessary to show whether or not the underlying fiber changes disappear in time, when the rats are again placed on a normal diet, as do those in cataract induced by galactose when the drug is withdrawn.

Coming back to the principal subject of this investigation, which is concerned with the pathogenetic significance of lens epithelial changes in cataract development, it is felt that a distinction has to be made between lenticular opacities produced by ionizing radiations and by radiomimetic drugs and those resulting from the administration of the three other cataractogenic factors studied. In the first case, damage affecting the cell nuclei in the germinative zone appears to initiate the series of pathologic events which finally lead to cataractous lesions. Usually these changes are not reversible and, as a rule, tend to progress. On the other hand, in galactose cataract, in alloxan cataract, and in cataracts caused by tryptophane deficiency, the lens epithelium in the germinative zone is but little involved with the exception of its mitotic activity. This effect on cell division does not seem to contribute to the extensive lens fiber changes. New normal lens fibers are formed upon withdrawal of the injurious factors, and residues of the damage are confined to circumscribed layers of the lens cortex.

Ophthalmology Branch
National Institute of Neurological Diseases and Blindness (14).

The first part of the reported work was carried out with the assistance of Mr. Leo Caravaggio, Miss Carmen Munoz, and Miss Ann Drungis, and the second part with the assistance of Mr. Caravaggio and Miss Patricia Grimes.

Dr. E. J. de Beer of the Wellcome Research Laboratories kindly provided us with 1,4-dimethanesulfonoxybutane Myleran® for use in these studies.

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FUNDUS PHOTOGRAPHY BY ELECTRONIC FLASH

PART I: THE SUCCESSFUL ADAPTATION OF ELECTRONIC FLASH TO THE NORDENSON FUNDUS CAMERA

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GENERAL INTRODUCTION

The four articles* to be published represent four years' research and experience in fundus photography using electronic flash as the light source. This series of articles will be limited to work on clinically useful procedures and equipment; those techniques whose complexity limits their usefulness to the research worker will be reported later.

Nature has provided us with a window, the cornea, through which it is possible to see a small portion of the true interior of the body undisturbed. Within limits even the light used to view it is physiologic. The importance and fascination of studying the secrets revealed are reflected in the eagerness with which Helmholtz's ophthalmoscope was greeted and the universal use of such instruments today, the large number of drawings which have been made of the views seen in various disease states, and the tremendous efforts which have been made to record these details photographically.

Despite the fact that photography was still in its infancy, Noyes made the first attempt at fundus photography in 1862, just 11 years after Helmholtz introduced his ophthalmoscope. Noyes failed, and so has almost everyone else who has tried. There are two fundamental problems to be overcome in order to photograph the details so easily seen with a simple ophthalmoscope. First, the reflections from the ocular media must somehow be avoided. Secondly, a light source must be found which is unusually intense.

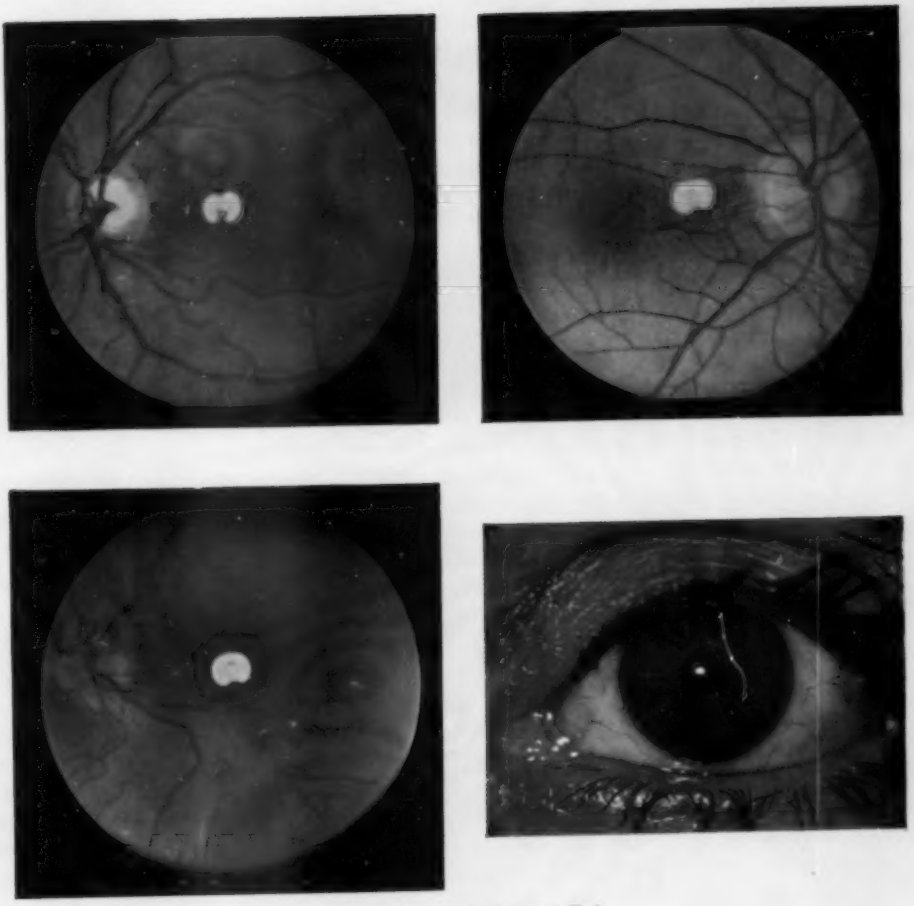
When light is thrown into an eye, a part of it is reflected back again by the anterior and posterior surfaces of the cornea and lens, and by multiple reflections between these surfaces. The expert ophthalmoscopist learns in part to avoid, but also to ignore or "see through" these reflections; the camera will always record them. For this reason a method must be found whereby light is introduced into the eye over a path which is somehow isolated from the pathway by which light returns to form the photographic image.

On the other hand, such separation of routes means that their dimensions as they traverse the pupil must be very small. Again, most of the light which falls on the retina is absorbed; thus little of the light which enters the eye will return to the camera. For these reasons a very brilliant source of light is required.

Only two men have ever designed worthwhile fundus cameras. In 1899, Dimmer began publishing his uniquely excellent re-

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* Part II. High resolution fundus photography.
Part III. A new fundus-anterior segment camera.
Part IV. Single exposure stereophotography of the fundus.



Fundus Photography by Electronic Flash

Upper left: Normal fundus oculi of a 15-year-old white girl.

Upper right: Angioid streaks in a 26-year-old white man.

Lower left: Fundus of left eye of a six-year-old white boy; diagnosis unknown. Right eye normal. The child was moving too rapidly to allow accurate focusing.

Lower right: Anterior segment photograph of a 53-year-old white man after removal of a pigmented nevus next to the upper lacrimal punctum.

sults, and in 1907 he published the classic monograph on fundus photography.[1] His camera made light enter one half of the pupil and only the light leaving from the other half was used to form the image on the film. Unfortunately his apparatus was much too large and complicated to be more than a research tool and only two such cameras have been made.[2]

In 1915, Nordenson described his relatively simple camera.[3] He utilized Gullstrand's principles of central reflex-free ophthalmoscopy whereby light is made to enter the periphery of the pupil, and only that part returning through the center of the pupil is used to take the picture. His camera was manufactured by Zeiss, and since World War II has been made by Bausch & Lomb. It has proven equal to the task of color, as well as black and white, photography. In the 40 years since its announcement no one has made a single worthwhile improvement in its basic design.

Adaptation of electronic flash

A. Light

Aside from purely optical considerations, the greatest technical difficulty in fundus camera construction has been the development of a source of light. Early investigators such as Rosebrugh (1864) used sunlight. Albertotti (1884) adapted the newly developed incandescent electric light. Cohn, after 23 years of work, reported in 1888 the first fundus photograph with recognizable detail (the optic nerve) and utilized magnesium flash powder for exposure. Guilloz (1893) reported a very clever gas lamp which was used for focusing and into whose flame magnesium flash powder was dumped at the proper moment for exposure. He succeeded in making the first photographs of seeing human eyes. An excellent summary of the early history of fundus photography is to be found in Dimmer's book.[1]

Dimmer used carbon arcs. Nordenson originally used sunlight but Kühl of Zeiss designed a special shutter so that carbon arcs could be used.[4] But the carbon arc which made the Zeiss-Nordenson camera possible also made it extremely difficult to operate. Consequently a great deal of effort has been expended in attempts to find a better light source. Zeiss manufactured a nitra lamp for the camera at one time. The adaptation of high wattage motion picture projection lamps has been reported,[5] but exposure times become one quarter of a second or longer.

I have personal knowledge of failures at attempting to adapt electronic flash, photoflash bulbs, the mercury arc, and special heavy tungsten filament lamps burned at just below the melting point of the tungsten. Within the past two years there have been three successful adaptations of the new FA5 xenon arc lamp, first by Hansell and Beeson in England[6] and then by Prince and his coworkers at Ohio State.[7] Most recently Norton[8] has made this lamp practicable. Saunders and Smith[9] have reported the successful adaptation of the zirconium arc lamp.

The firm of R. A. Dudragne, France, has recently advertized a fundus camera which uses an incandescent lamp for focusing and electronic flash to take the picture. Both lamps are mounted off the camera axis. Prices start at 700,000 francs ($2,000.00) plus duty and transportation costs.[10]

In 1953, Ogle reported[11] the adaptation of electronic flash using a power supply which made the bulb flicker at low intensities for focusing and then flash brilliantly to take the picture. His power supply stores relatively large amounts of energy (200 watt-seconds) and is relatively bulky and complex. Unfortunately it does not produce enough light for Kodachrome photographs, Ektachrome being used instead. At the time of his report the Ektachrome had to be custom processed[12] because of underexposure, but certainly the new high speed Ektachrome should be adequate.

Large amounts of time and money have been spent in research along these lines. It is remarkable that in spite of the inability of most persons to obtain good photographs with the Nordenson camera with carbon arcs, Zeiss sold 360 of them[13] and Bausch & Lomb is now selling them for $1,875.00 apiece. Thus there apparently is a real need for an easy way to photograph the fundus.

B. Advantages of electronic flash

There are several advantages in using electronic flash as a light source. First of all, exposure time equals the duration of the electronic flash, which in my unit is about 1/3,000th of a second. The Nordenson camera using carbon or xenon or zirconium arcs requires exposures of 1/10th to 1/25th of a second for Kodachrome. This is far too long to obtain pictures unblurred by subject motion. The finest movements of the fixating eye amount to two seconds of arc and occur 50-100 times a second;[14] with electronic flash even these are effectively eliminated. Neither voluntary subject motion nor camera vibration will degrade the recorded image resolution and with electronic flash, though difficult, it is not impossible to photograph even unco-operative subjects such as children and animals.

With electronic flash the complex custom shutter required for the arc light is no longer needed, because dimming of the light source is accomplished electronically in the flash unit. Because electronic flash tubes are relatively cool, heat-absorbing elements are not required, as for arcs. Because electronic flash tubes do not smoke, the problem of keeping lenses clean does not arise as with the carbon arc.

Electronic flash tubes do not change their size or shape in use, so that once the bulb is correctly mounted in the camera no further adjustment is needed. Furthermore, tubes can be made so nearly identical by the manufacturer that correct mounting in the camera is automatic; in other words the bulbs can be made "prefocused." The major difficulty in operating the Nordenson camera as it is now made is in keeping the carbon arc crater exactly centered at all times as it burns. This difficulty and the variations in the burning characteristics of the carbons lead to wide variations in both the brightness and color of the effective light source, and make consistent color picture quality impossible.

Electronic flash tubes are extremely constant as to both the amount and the color of the light they emit throughout their life, and indeed have been proposed as "standard" lamps.[15] Their spectrum is independent of voltage, and they have a relatively low modulation ratio: that is they do not vary much in brightness with voltage changes. A change in line voltage from 105 volts to 120 volts is theoretically equivalent to only one-third of an f/stop, and little difference can be seen in the pictures actually made at these extremes in voltage.

Electronic flash tubes can be made in a large range of sizes and in virtually any linear or curvilinear shape to which glass tubing can be bent.

C. Experimental: optical components

Consideration of the principles of fundus camera design convinced me that it should be possible to adapt successfully electronic flash to the Nordenson camera.

It seemed that the most efficient and proper place for the light source, however, was directly on the camera axis without intermediary optical systems and that this arrangement could be achieved with electronic flash.

In the near future I hope to publish a mathematical analysis of fundus camera design. In the process of this work eight fundus cameras have been mathematically analyzed and/or tested. Re-evaluation of this work and of the successful fundus cameras and ophthalmoscopes designed by others has led to the formulation of a general theory

of the design of such instruments. The theory itself is outside the scope of this paper but this work provided me with the background needed for the adaptation of electronic flash to the Bausch & Lomb camera as described here and also with the requisite experience to do further work.

Two adaptations of electronic flash to the Bausch & Lomb-Nordenson camera have been made. The first was a simple exercise duplicating Ogle's work: the carbon arc housing was removed and an electronic flash tube substituted at the precise place where the carbon arcs had been. The Kodachromes were very underexposed with poor resolution, just as his were.

I then removed the entire Bausch & Lomb illumination system (carbon arcs with housing and spring motor drive, aspheric condensing lens, prism, filters, custom shutter, and prism slit assembly), and replaced the prism slit assembly with a curved electronic flash tube (fig. 1).

There were a number of technical difficulties. It was necessary to mask the bulb so that light did not shine back directly into the camera lens. Materials such as heat-resistant paints would vaporize and disappear when the tube was flashed, plastic electrical tape smoked, and metal foil was eaten away by the action of the high grid voltage. I found that DuPont's Teflon plastic would probably work well provided enough were needed so that the cost would not be prohibitive per unit. I am actually using Scotch Electrical Tape Type 27 (fiberglass with thermo-setting adhesive) and wherever special shapes need to be encompassed I use

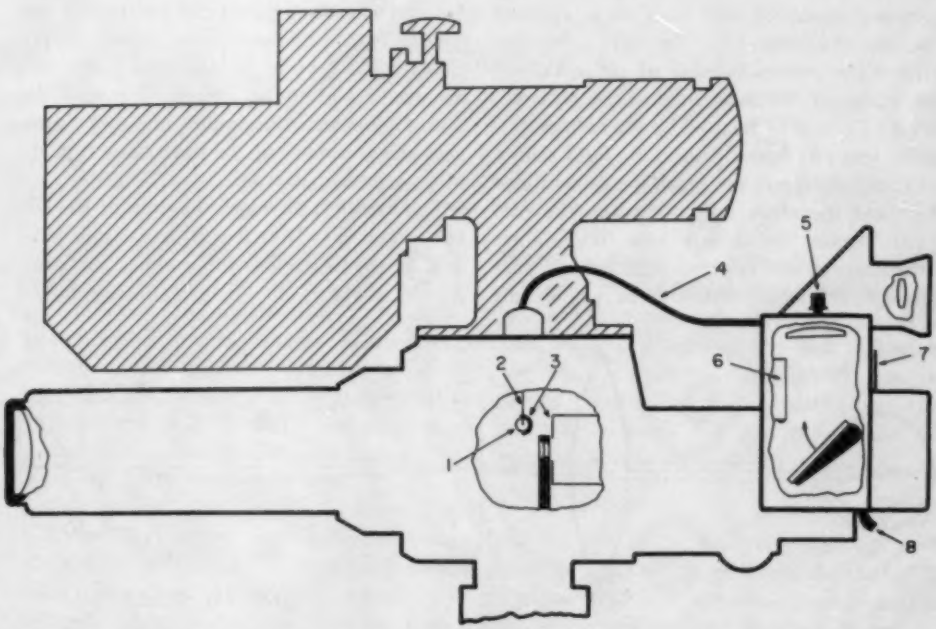


Fig. 1 (Drews). Bausch & Lomb Nordenson fundus camera with electronic flash light source. The shaded area indicates the former position of the carbon-arc illumination system. New components are: (1) Electronic flash tube. (2) Leads to the flash tube. (3) Masks. (4) Cable from the control box to the flash tube. (5) Lever switch S_3. (6) Microswitch for synchronization, activated by the mirror. (7) Kodak Wratten gelatin 81EF filter in a paper jacket. (8) Cable from the power supply to the control box.

asbestos paper. This paper is very cheap and when damp it can be molded to cover almost any shape tube. Excess paper when it dries is trimmed off with a scissors and the edges touched up with a moist brush.

The wheel of corrective lenses in the Bausch & Lomb camera was removed to allow a simple tubular mask to be placed behind the camera lens to prevent stray light from reflecting about in the camera and fogging the film.

The initial photographs were too blue but this was easily corrected with a Kodak Wratten 81EF filter. I mounted this in a simple paper jacket underneath the film holder adapter.

Referring to the diagrams of the optical system (fig. 2): Light from the electronic flash tube (7) is focused by the ophthalmoscope lens (4) onto the periphery of the patient's pupil (3) and from there spreads out over the retina (1). The light returning toward the camera because of reflections of the image of the flash tube in the patient's pupil (3), will be focused by the ophthalmoscope lens (4) back again to the light source (7); this light will not reach the camera lens (6) and therefore will not reach the film (10). Again, the camera lens (6) will receive only those rays of light which pass through a selected central area (2) of the patient's pupil. Note that this selected central area is defined by the image of the camera lens formed by the ophthalmoscope lens in the patient's pupil (2). Light returning from the fundus is rendered more or less parallel by the patient's lens and cornea and is focused by the ophthalmoscope lens near its focal plane (5). The camera lens refocuses the image of the retina formed by the ophthalmoscope lens on the focusing reticule (9) via the reflex mirror (8). When the picture is taken the mirror is lifted out of the way at the proper moment so that light can fall on the film (10).

D. Electronics

My good friend, Mr. David Gast, an electrical engineer, helped design and build a very simple flicker-flash type electronic flash unit. Conventional circuitry is used throughout, and a minimal number of electronic components are employed. The power supply pictured has been in use for three years, and has never had to be altered. We have recently constructed a simpler and more compact power supply of the same basic type, to be described in Part III.

Referring to the block diagram of the circuitry (fig. 3): Note that S_2 is a double pole, double throw, center-off switch, its component parts in the diagram being linked

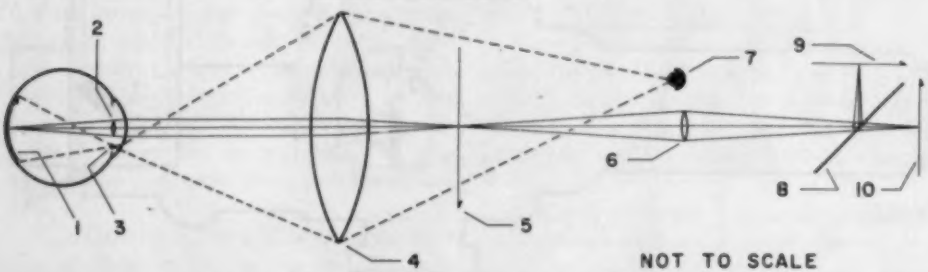


Fig. 2 (Drews). Optical system of the Nordenson fundus camera with electronic flash light source. Dashed lines define the illumination system; solid lines illustrate fundus image formation. (1) Fundus of the eye to be photographed. (2) Image of the camera lens as formed by the ophthalmoscope lens. (3) Image of the electronic flash light source as formed by the ophthalmoscope lens. (4) Ophthalmoscope lens. (5) Image of the fundus as formed by the ophthalmoscope lens. (6) Camera lens. (7) Electronic flash tube and mask. (8) Mirror. (9) Image of the fundus on the focusing reticule. (10) Image of the fundus on the film.

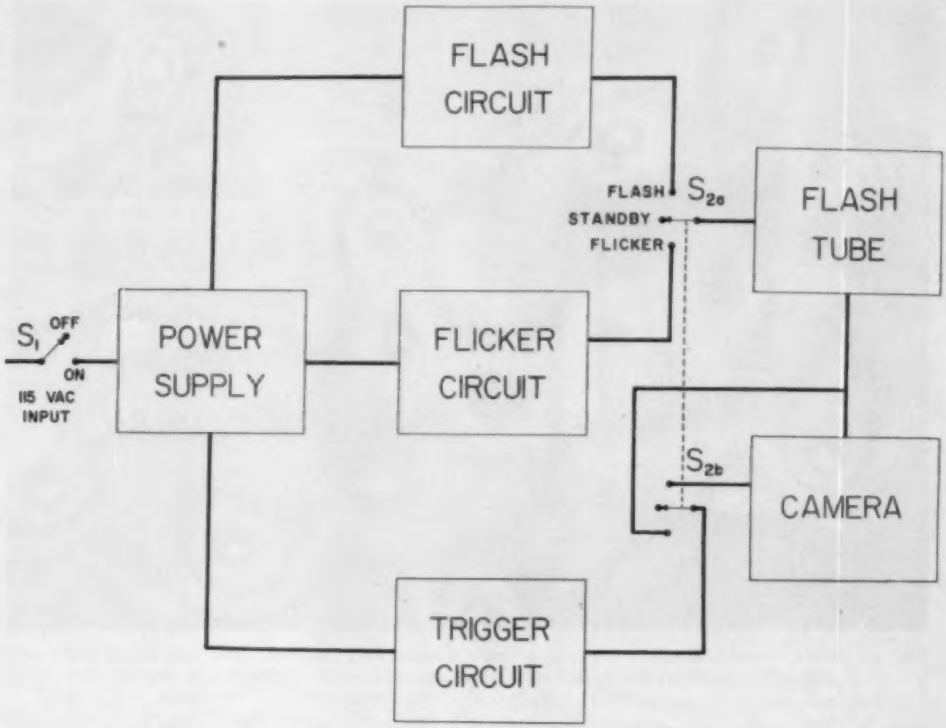


Fig. 3 (Drews). Block diagram of the electronic flash circuit. S_{2a} and S_{2b} are the components of the double-pole, double-throw, center-off switch S_2.

conventionally by a dotted line. Initially, S_1 is off and S_2 is in the standby (center-off) position. Closing switch S_1 turns on the power supply which provides the necessary voltages to the rest of the components. By the time the flash circuit is fully charged (approximately 20 seconds) the other components have been sufficiently warmed up. This is indicated by a ready light.

To focus, S_2 is then set to the flicker position and the trigger circuit regularly discharges the flicker circuit through the flash tube resulting in 60 uniform, regular, low intensity flashes per second. This rate is well above the flicker fusion frequency of the eye and gives a constant-appearing light. When the fundus is properly focused, moving S_2 to the flash position raises the camera mirror and causes the trigger circuit to discharge the flash circuit through the flash tube, resulting in a single brilliant flash for exposure of the film. S_2 is spring loaded so that when it is released the unit returns to the standby position. The 20 seconds required for the flash circuit to recharge may be used to wind the film and adjust the camera for the next picture.

E. Operation

I hesitate to say that this unit (fig. 4) is easy to operate because everyone, including Dimmer with his monstrous apparatus, has made the same claim! Having dilated the patient's pupil maximally and loaded the camera with Daylight Kodachrome 828 (eight exposures per roll):

1. Turn on the power supply (S_1).
2. Position the patient comfortably in the

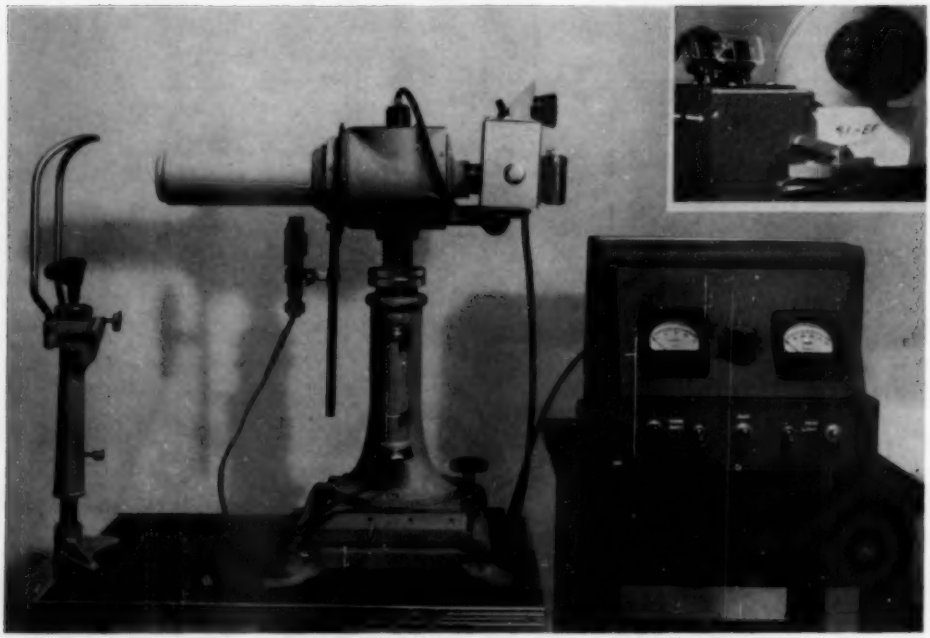


Fig. 4 (Drews). Bausch & Lomb Nordenson fundus camera with electronic flash light source and power supply. Inset shows the 81EF filter holder mounted beneath the film holder adapter.

chin and forehead rest and turn on the fixation light.

3. When the "ready" light flickers, turn on the focusing light (S_2).

4. Focus and center the image of the flash tube in the subject's pupil.

5. Focus the image of the fundus on the viewing reticule and make final adjustment of the fixation light and the optical alignment of the camera so that the desired part of the retina is focused without flares.

6. Make the exposure by pulling back S_2 to the flash position.

7. Release S_2 and wind the film. More pictures may now be taken by repeating steps 5 to 7, or the unit may be turned off by turning off S_1.

F. Results

I have been able to show that this unit is capable of taking consistently excellent photographs, which are strikingly uniform with respect to color and density (see color plate).

Three skills are necessary to obtain good photographs:

1. The photographer must be able to focus accurately on a reticule, a procedure which sounds simple but which usually requires some practice.

2. He must be able to see any flares which may overlay the image of the fundus if the camera is not properly aligned. The skilled ophthalmologist has learned to repress or "see through" the flares which tend to obscure retinal detail when using an ophthalmoscope. To use this camera he will have to learn to see these flares again since the camera will always record them.

3. Unfortunately he must remember to wind the film.

I think that the detail recorded on the color photographs is better than that obtained with any other unit now in use. Further, the camera is now so easy to operate that any-

one who can learn the three skills listed above should be able to take consistently good color photographs without any assistance.

G. Availability

The Bausch & Lomb camera sells without the AC adapter for $1,800.00. I hope to be able to have the electronic flash adapter unit manufactured in the near future. The power supply has been redesigned and it is now compact enough to be mounted directly on the Bausch & Lomb fundus camera so as to eliminate the need for an extra table, connecting cables, and so forth. Costs should be moderate.

Summary

An electronic flash light source of the flicker flash type has been successfully adapted to the Nordenson fundus camera. The flash tube itself is mounted in the camera on the optical axis, without intermediary optical systems. The unit is capable of uniform, properly exposed and color balanced Kodachrome color photographs with good resolution. It is small in size, relatively inexpensive, and relatively simple to operate.

7361 Cornell (5).

Patents pending.

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MOLTEN METAL BURNS OF THE INFERIOR FORNIX

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Though severe chemical burns of the eye and adnexa are best treated by the immediate removal of the involved skin and conjunctiva to eliminate the continuing noxious chemical influence (especially when it is of an alkaline nature) and to apply free skin or mucosal grafts, it cannot be said that the best management of a molten metal burn of the eye and adnexa has been evolved.

Is it better to avoid early surgery and to delay reconstruction for a year, or is immediate resection with grafting the better plan?

Would it be wrong to withhold surgery entirely, and treat such injuries with irrigation and cortisone topically with irradiation as needed later, and permit the lower lid and lower sclera to remain fused?

The answers to these questions will require studies more extensive than those presented in this paper. However, the experiences gained here show that while the removal of symblephara and a reconstruction of a lower fornix with mucosal grafts are important, the chief problem is to keep vascularization from the cornea without using excessive radiation which would lower corneal metabolism, with consequent loss of transparency.

Despite extensive safety measures that are constantly being improved, occasionally a mold of cast iron or steel will explode and some of the molten metal will fall into the inferior fornices of a worker's eyes. Among our 10 patients injured in this manner in the past eight years, three have been burned severely, one moderately, and the other six minimally. This report is of the severe and moderate burns. None of the severe burns was bilateral

CASE REPORTS

CASE 1

A. S. D., a 40-year-old foundryman in November, 1948, received molten iron in both lower fornices, a minimal amount getting in the right lower fornix and a maximal amount filling the left lower fornix. Necrosis of the conjunctiva and episclera in the lower nasal quadrant developed soon afterward. At our first examination two months later he said that his local physician had treated the forniceal adhesions by breaking them up daily with a muscle hook.

At our first examination, in January, 1949, the right cornea showed only a few scars and vascularization of the lower limbus, and no symblepharon formation. The corrected right vision was 20/20. In the left eye, a posterior symblepharon had developed in the lower half, with fixation of the lid to the cornea and sclera. The left vision was 20/400. The ocular tension of both eyes was 18 mm. Hg.

An acrylic ring conformer was made for constant wearing to exert pressure from the upper fornix against the symblepharon below. However, the conformer caused pain and after two months of attempting to wear it, it was discontinued.

By March, 1949, vascularization of the left cornea began to develop (fig. 1). Irradiation with the beta applicator was begun, as presented in a later paragraph.



Fig. 1 (Callahan and McKerricher). Case A. S. D. Appearance two months after injury. Vascularization of the cornea is beginning and there is an extensive posterior symblepharon.



Fig. 2 (Callahan and McKerricher). Case A. S. D. Appearance two months after surgical repair. Symblepharon has been removed and penile mucosal graft has been used to reconstruct a new lower fornix.

Surgery. In July, 1949, removal of total symblepharon of left lower fornix with grafting of penile mucosa (obtained by circumcision) to replace bulbar and palpebral conjunctiva (fig. 2) was undertaken. In March, 1950, entropion of upper and lower lids was corrected with Ewing's modified entropion repair and lateral canthotomy to make a more normal lateral canthal angle (fig. 3). In October, 1950, secondary repair of traumatic ectropion of upper lid was done and in January, 1951, the cicatricial entropion of lower lid was repaired with oral mucosal graft. Extensive cicatricial tissue was removed from between the mucosal graft and sclera in May, 1951, and surgical construction of the intermarginal lid adhesions was done to prevent contraction of either the anterior or posterior lamina of the lids. In July, 1952, the intermarginal lid adhesions were divided.

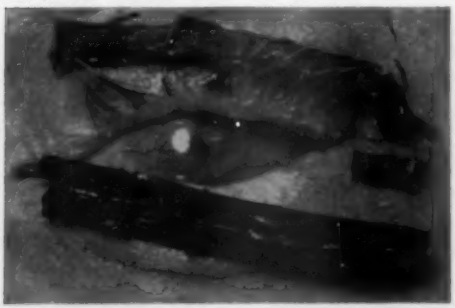


Fig. 3 (Callahan and McKerricher). Case A. S. D. Entropion of upper and lower lids has been corrected with modified Ewing's entropion repair. In spite of six operations, removal of the eye was necessary.

During the surgical procedures, the globe began to show degenerative changes, especially in the cornea. The lower nasal quadrant of the cornea thinned out and the iris became adherent to its posterior surface. Bullous keratitis developed. Vascularization of the cornea increased and the ocular tension became elevated (50 mm. Hg). Endophthalmitis developed, the eye became painful, and, in March, 1956, it was removed.

Irradiation. From February, 1949, until April, 1952, a 50 mc. beta radium^{D} applicator* was used to attempt to prevent vacularization of the cornea. At 15 separate office visits the applicator was applied for three minutes to one, two, or three corneal or limbal areas. This was ineffective in preventing corneal vascularization, so electrolysis was used to destroy large limbal vessels on two occasions. In April, 1952, a 75 mc. strontium applicator† became available, and, over the duration of four months, it was applied for two minutes each to one, two, or three corneal or limbal areas.

CASE 2

J. M., a 47-year-old man, in January, 1951, sustained a severe burn from molten iron in the right lower fornix. When seen by us for the first time one month after injury, the right vision was reduced to counting fingers at three feet. There was a dense intracorneal infiltrate throughout the stroma of the lower nasal quadrant of the cornea, and the lower nasal half of the cornea stained with fluorescein. The eye was moderately inflamed, it was not painful, and the ocular tension was 30 mm. Hg. Local treatment consisted of topical cortisone and pilocarpine nitrate. During the 10 months that were allowed to elapse before surgery was begun, an extensive symblepharon developed between the lower lid and the globe, and the right lacrimal drainage system became completely stenotic (fig. 4).

Surgery. In November, 1951, the complete symblepharon in lower half of globe was removed which exposed the fusion of the tarsus of the lower lid with the ciliary body; plastic repair of the sclera was performed and then a section of penile mucosa was grafted and held in place by sutures tied over rubber strips (fig. 5). In trying to prevent vascularization of the cornea, the strontium applicator was applied to the cornea for a total of 18 minutes in two areas.

Re-examination in January, 1957 (fig. 6) showed a cloudy cornea with reduction of vision to 20/400. The graft extended from the lower limbus at the periphery of the cornea downward to form a full fornix, and extended upward on the posterior surface of the lid. There was no limitation of the motion of the eye.

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* Dr. Harold Swanberg, Quincy, Illinois.

† Tracerlab, Boston, Massachusetts.



Fig. 4 (Callahan and McKerricher). Case J. M. Extensive symblepharon between lower lid and cornea.

CASE 3

D. A. S., a 34-year-old man, received molten iron in the left lower fornix in March, 1948. Examination a few hours later showed extensive tissue coagulation, of such severity that a complete slough of the lower fornix and sclera was feared. In a month, a complete symblepharon of the lower fornix had developed (fig. 7). Attempts to wear a flat acrylic ring were so painful that they were discontinued.

Surgery and irradiation. After purposely waiting for three months so that most of the cicatrization could occur, in June, 1948, the symblepharon was removed and the lower fornix reconstructed with penile mucosa on the palpebral and bulbar surfaces. The immediate functional and cosmetic result were good. In January, 1949, the advancing edge of the mucosal graft was transplanted from the cornea toward the fornix.



Fig. 5 (Callahan and McKerricher). Case J. M. Appearance one week after reconstruction of lower fornix with penile mucosal graft.



Fig. 6 (Callahan and McKerricher). Case J. M. Appearance five years after surgical repair.

Beta irradiation was applied at the lateral limbus in January, February, and March. In June, 1949, a labial mucosal graft was applied to the lateral canthus after removing the encroaching cicatricial tissue. Beta irradiation was given again in August and December, 1949. In 1950, granulation tissue was trimmed from the lower cornea and beta irradiation was given for five minutes each on three occasions for neovascularization of the lower limbus. In 1951, further cicatricial tissue was excised and the eye received beta irradiation in various areas along the lower limbus for a total of 18 minutes. In August, 1951, more than three years after the injury and after five operations and extensive beta irradiation, the corrected left vision was 20/20. From the subconjunctival scarring at the lower fornix, 4.0$^{\Delta}$ left hypophoria had developed. Though the penile mucosa was thick, smegma has never

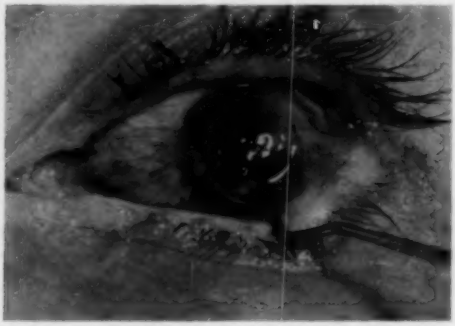


Fig. 7 (Callahan and McKerricher). Case D. A. S. Lateral half of lower fornix involved with symblepharon. Vascularization is also extensive, proceeding from the medial limbus.



Fig. 8 (Callahan and McKerricher). Case D. A. S. Appearance after five operations. Reconstructed fornix is shown with aid of muscle hook which holds down the lower lid. Corrected vision, 20/20.

formed, nor has an unpleasant odor ever been noted (fig. 8).

In 1952, the patient was referred to Dr. Charles Iliff who recommended a lamellar keratoplasty of the lower cornea to be followed by early irradiation. Dr. Iliff irradiated the palpebral conjunctiva of the upper lid, giving 15 gm. seconds.

In January, 1953, lamellar grafting was performed. Despite early postoperative beta irradiation the graft became vascularized and most of it was opaque. Topical cortisone was used extensively and irradiation was given with the strontium applicator during 1954. Occasionally the ocular tension became elevated higher than normal, but responded satisfactorily to pilocarpine. In July, 1955, a six-mm. penetrating keratoplasty was done in the lower cornea, along with an iridectomy of the

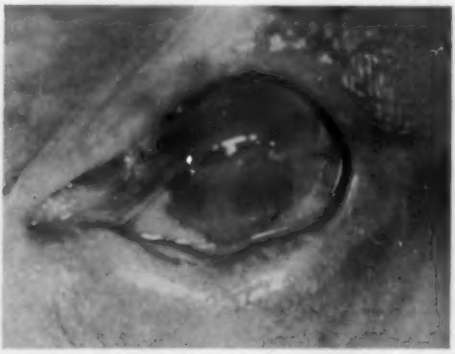


Fig. 9 (Callahan and McKerricher). Case D. A. S. Appearance six years after injury. Seven surgical procedures have been performed and extensive radiation given.



Fig. 10 (Callahan and McKerricher). Case H. R. Appearance three years after injury. This injury was less severe than in the other three cases. Surgery was not required. Topical cortisone and strontium irradiation have been used.

underlying iris tissue. This graft was transparent in its upper portion, but as the lower portion had to be joined to the sclera, some vascularization developed. These blood vessels have not extended across the graft during the year of postoperative observation, but the graft has gradually become opaque. By January, 1957, the vision was reduced to light projection (fig. 9). The vascularization of the cornea has stopped, the ocular tension is normal and there is no ocular discomfort.

CASE 4

H. R., an 18-year-old boy, received molten steel in the lower left fornix in July, 1952. All of the metal was removed within a few moments, and the fornix was washed with tap water continuously for 15 minutes. Then cortisone was used topically every 15 minutes in the fornix for the remainder of the day, and cortisone ointment instilled into the fornix at night. For a week cortisone was used topically in the fornix every half hour during the day, and cortone ointment at night. The use of cortisone was gradually decreased, and by August, the lower part of the cornea and the lower nasal quadrant of



Fig. 11 (Callahan and McKerricher). Case H. R. Appearance of eye in elevation. Vision, 20/20.

the conjunctiva had ceased to stain with fluorescein. The visual acuity of the left eye was 20/100.

In September, vascularization began along the lower nasal limbus. The strontium applicator was applied in two areas of the lower limbus for one minute each. Strontium irradiation was given along the limbus as follows: two minutes each; December, two areas, three minutes each, January, 1953, two areas, three minutes each. By May, 1953, the corrected vision with a strong cylinder (previously not required) was 20/20. By June, 1954, the newly formed vessels at the lower limbus were so attenuated that further irradiation was not required.

In October, 1956, the vessels along the lower nasal limbus were unchanged. Additional irradiation was unnecessary. Corrected vision remained at 20/20 (figs. 10 and 11).

Practical points in managing molten metal burns

1. Thorough cleansing of the fornix followed by extensive irrigation with water, saline, or boric acid is the best immediate treatment of molten metal forniceal burns. This treatment should be followed by frequent instillations of cortisone or cortisone derivatives.

2. Breaking up adhesions by forcibly separating the globe and lid merely stimulates more cicatrization.

3. Insertion of a conformer into the palpebral fissure to exert pressure from the upper to the lower fornix is valueless as a form of early treatment. This ophthalmopedic should be used only after cicatrization is complete, the cicatricial tissue has been removed, and the necessary grafting performed.

4. When large areas of mucosal grafts are required, genital mucosa is our preference. We have had no complications in using it.

5. The chief problem in salvaging vision and the globe is the prevention of corneal vascularization without extensive irradiation of the limbal area, which leads to a lowered corneal metabolism. Reconstruction of the lower fornix is a secondary consideration.

Results

In four eyes with molten metal burns of the lower fornix, one of moderate severity recovered normal vision; two globes were salvaged with little remaining vision, and one eye required removal from the group of three severely damaged.

The best management of a molten metal burn of the lower fornix has not yet been evolved. These observations may be useful as a beginning for further study.

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THE HISTORY OF THE AMERICAN COMMITTEE ON OPTICS AND VISUAL PHYSIOLOGY

AN OFFICIAL HISTORY APPROVED BY THE COMMITTEE

Current problems pertinent to ophthalmology have been the focus of all activities of the American Committee on Optics and Visual Physiology. The primary aims of the committee have been to raise standards within the specialty of ophthalmology and in related fields and, by means of research and systematic investigation, to increase knowledge and provide scientific facts concerning controversial subjects. The committee has served in a consulting capacity, as a fact-finding body, and as a source of reliable information.

Originally appointed as the Committee on Optometry, in 1927, its first assignment was to consider the relations of ophthalmology and optometry. The idea for such a national committee stemmed from the experiences of a committee on optometry sponsored by the New York Academy of Medicine. Dr. Walter Lambert, as chairman of the committee, and the membership consisting of Edgar Thompson, H. H. Tyson, and Conrad Berens, secretary, were instrumental in having interprofessional problems considered on a national level. The first meeting of the national Committee on Optometry was held on May 20, 1927, at the meeting of the American Medical Association in Washington, D.C.

The committee realized that if it explored such phases of the subject as the place of the optometrist in school examinations and his possible co-operation in hospitals, its work might assume wide scope and importance. Moreover, it recognized the challenging opportunity of educating both the medical and associated professions and the public in regard to eye care. It was, therefore, considered advisable at the first meeting to request that the sponsoring organizations, the American Ophthalmological Society, the Section on Ophthalmology of the American Medical Association, and the American Academy of Ophthalmology and Otolaryngology, change the name of the committee so that it would reflect the broader scope of the work and also grant permanent status. Nine members were appointed, three from each society. In 1949 the committee was enlarged to include three representatives appointed by the Association for Research in Ophthalmology. To ensure a rotating membership the committee members are appointed for a three-year term.

The caliber of the original committee set the pace for the appointment of ophthalmology's most distinguished representatives. There were Charles A. Bahn, William L. Benedict, Conrad Berens, E. V. L. Brown, George Crampton, Edward C. Ellett, Edward Jackson, James M. Patton, and William H. Wilder.

Through the years the personnel of the committee changed to include S. Judd Beach, Alfred Cowan, John N. Evans, William H. Luedde, Walter B. Lancaster, Sanford R. Gifford, Frederick C. Cordes, Lawrence T. Post, Thomas D. Allen, Kenneth C. Swan, Avery DeH. Prangen, Henry A. Imus, Richard G. Scobee, Kenneth N. Ogle, Hermann M. Burian, William F. Hughes, Jr., Gerald Fonda, Arthur M. Culler, Victor A. Byrnes, Arthur Linksz, William C. Owens, and M. Luther Kauffman.

The present committee consists of: Conrad Berens, Hermann M. Burian, Victor A. Byrnes, Frederick C. Cordes, Gerald Fonda, Henry A. Imus, M. Luther Kauffman, James E. Lebensohn, Arthur Linksz, Kenneth N. Ogle, William C. Owens, and Kenneth C. Swan.

Dr. Edward Jackson served as chairman of the committee until 1937. Following his term of office Dr. Lancaster assumed the chair until 1947. Dr. S. Judd Beach and Dr. Lawrence T. Post served as chairmen for the spring meetings in 1948. Dr. Lan-

caster resumed the chairmanship at the fall meeting in 1948, and continued in this position through the year 1951. Dr. Lawrence T. Post was chairman for the year 1952, followed in office by Dr. Conrad Berens, the present chairman, who had served as secretary-treasurer of the committee since its organization.

Because the members of the committee reside in different sections of the country a national picture of ophthalmologic problems has been possible. Any problem or topic investigated by the committee is discussed by the committee as a whole, referred to a special subcommittee for detailed study, and the findings then passed upon by the entire committee. The committee has a policy of consulting authorities in various ophthalmic fields and frequently such experts have been invited to attend the meetings.

At least two meetings are held each year, coinciding with the meetings of the American Ophthalmological Society, the American Medical Association, and the American Academy of Ophthalmology and Otolaryngology. In some years it has been necessary to hold special meetings in order to cover the entire agenda. The annual reports to the parent organizations include progress reports as well as final reports on the varied activities of the committee. These appear in the minutes of the sponsoring societies.

The committee has co-operated with such organizations as the National Society for the Prevention of Blindness, the American Foundation for the Blind, the United States Bureau of Standards, the National Council on Schoolhouse Construction, the Council on Physical Medicine of the American Medical Association, the Council on Orthoptic Training, and the Departments of the Army, Navy, and Air Force.

A great deal of the committee's efforts has been devoted to the study and analysis of the relationship of optometry and ophthalmology, but its activities have also included research on many phases of eye care. It has sponsored research and encouraged and suggested fields of endeavor to other workers, for instance, the evaluation of electrosurgical apparatus at the University of Oregon Medical School.

It has been a source for obtaining decisions on problems vital to the prevention of blindness, evaluations of new ophthalmic instruments, both foreign and domestic, and guidance in such fields as orthoptic training, illumination, contact lenses, myopia, tinted lenses, color blindness, visual standards for applicants for motor vehicle operators' permits, terminology and classification of motor anomalies, and nomenclature for designating visual acuity.

Interprofessional relations

In attempting to solve the many difficult problems involved in the relations between ophthalmologists, optometrists, opticians, and the public, the committee has consulted with optometrists, opticians, and representatives of the National Society for the Prevention of Blindness as well as with manufacturers of lenses. The committee has been outspoken in its criticism of the resolution passed by the Section on Ophthalmology of the American Medical Association in 1935 which declared it unethical for members of the American Medical Association to give lectures or courses of instruction to or consult with anyone not associated with the actual medical service.

In 1940, the committee called attention to some incontrovertible facts: 75 percent of people who obtain glasses go to optometrists for them. Most of these individuals need nothing more but some (in the aggregate many thousands) have pathologic conditions needing the attention of ophthalmologists. The question was raised as to whether ophthalmologists who are the best qualified and who have most of the accumulated knowledge of eye diseases should refuse to share their knowledge. It was philosophized that the only way to combat ignorance and folly is by the dissemination of truth.

In the same year, the subcommittee on

optometry recommended to the entire committee that ophthalmologists be urged to cooperate with optometrists in their education, especially concerning medical conditions which might be of danger to public health and which might result in blindness or impaired vision. A method of approach to this problem was thought to be through special committees on ophthalmologic public relations of the county medical societies contacting accredited members of local optometric societies.

The committee recommended that it be authorized to co-operate with the committee appointed by the American Optometric Society to confer with the American Committee on Optics and Visual Physiology concerning the education of optometrists and ethical and other relations between ophthalmologists and optometrists. A resolution permitting this conference was passed by the American Medical Association. The committee further recommended that it be empowered to suggest a sufficiently complete medical course to make the graduates of schools of optometry better fitted to recognize patients who should be referred to physicians.

A meeting of the two groups was held in May, 1941, during which changes in the optometry curriculum were suggested and new resolutions proposed to rescind the 1935 resolution of the Section on Ophthalmology of the American Medical Association. At an executive session of the Section on Ophthalmology the 1935 resolution was rescinded but the proposal to place the responsibility for public relations of ophthalmologists upon the local medical societies failed. However, the next year, 1942, the Section on Ophthalmology in a special meeting reaffirmed the 1935 resolution on optometry.

In June, 1949, it was realized that the previous work of the committee had succeeded merely in awakening ophthalmologists and optometrists to the need for improvement in their standards and relations. After some thought and consideration it seemed that the name, membership, and objectives of the subcommittee on optometry might be altered to fit existing conditions. Consequently in May, 1950, the Joint National Committee on Eye Care, later named the National Interprofessional Committee on Eye Care, was suggested. Membership was to include ophthalmologists, optometrists, and opticians.

The meetings of this committee produced frank discussions of many areas of friction. Friction, however, developed between optometrists and opticians. An outcome of the situation was that the American Optometric Association would not permit optometrists to serve on committees which included opticians. It was the opinion of the American Committee on Optics and Visual Physiology that this co-operation was ineffectual until such a time as the American Optometric Association rescinded its action, and the committee withdrew from the National Committee on Eye Care. Meanwhile Conrad Berens was appointed to co-operate with the American Medical Association in its consideration of interprofessional problems.

Thus, the relations of ophthalmology, optometry, and opticianry appear to become more involved with but little hope for an immediate solution. Only by gradual education and evolution can the goal of co-operation be attained. A sensible solution to these important intergroup problems is desired by many ophthalmologists in the interest of public health and the prevention of blindness.

An allied problem is that of dispensing glasses. This topic was fully considered and laws for the regulation and licensing of dispensing opticians were approved in principle some years ago.

Because the committee was not unaware of certain practices subject to criticism within its own profession, an extensive investigation was made to ascertain the practice of selling glasses in various parts of the country. It was recognized that there was a prevalent practice among opticians to give rebates to the prescriber, thereby keeping

the cost of glasses for the patient at an unduly high price. Plans to remedy the situation were studied with some of the leading manufacturers of glasses. The following plan was finally evolved:

"In communities where there are no straight retail dispensors of optical goods (other than optometrists) physicians who do not desire to participate in any way themselves in the retail dispensing of glasses may refer their patients directly to the wholesale houses who ordinarily act as oculists' agents in the dispensing of glasses. On such reference, the wholesale houses will furnish to patients, on specific prescriptions of such physicians, glasses of comparable quality, including protected lines, at the minimum retail price prevailing in the community and will assume responsibility for breakage, adjustments, collections, and so forth, such as are ordinarily assumed by their accounts."

Thus, major optical houses as well as ophthalmologists and opticians were consulted in seeking a solution to these problems.

Optical instruments and lenses

As early as 1931 the committee emphasized the importance of having some check on the value of optical instruments and apparatus placed on the market. Consequently, reports to the parent organizations included the evaluation of new instruments. By referring to the minutes of the national eye societies, ophthalmologists can obtain information that will guide them in the purchase of equipment.

It was found that it was not enough to have subcommittees attempt to analyze new instruments, or the character and claims for lenses and special kinds of glass, advertised and sold under copyrighted names. At the time many such glasses were pressed upon the public with misleading statements and claims, similar to those made for some proprietary drugs and patent medicines. The committee offered its services in relation to optics and lenses to the Council on Physical Medicine of the American Medical Association. In addition it was successful in having a representative appointed as an advisor to the Council on Physical Medicine to pass on advertising for the *Journal* of the American Medical Association.

Eventually the work of collaborating with the A.M.A. group assumed such proportions that the council appointed a group of consultants on ophthalmology to advise the council on questions pertaining to apparatus used in the field of ophthalmology. Although the consultants were representative, the group did not function satisfactorily and a similar service was still being rendered by the American Committee on Optics and Visual Physiology. It was, therefore, recommended that the consultants appointed by the council might include the entire membership of the American Committee on Optics and Visual Physiology.

The dispensing of contact lenses as early as 1946 was a highly commercialized service. Certain unethical practices by persons other than physicians who fit contact lenses were brought to the attention of the committee. In order to present the facts of the situation to the medical profession an article was prepared for publication in the *Journal* of the American Medical Association. Another article for lay consumption appeared in *Today's Health*.

Night-driving lenses were investigated in 1955. It was recommended that no filters of any type be interposed between the eyes of the driver of a car and the road. This was also to apply to windshields. The committee believed that manufacturers should be encouraged to use clear heat-absorbing glass which absorbs only the infrared and allows all visible light to pass through.

In an investigation of the standardization of ophthalmic lenses it was concluded that to the ophthalmologist the quality, accuracy, fit, and appearance of the finished glasses are all important. The ophthalmologist should indicate in his prescription whether the glasses

are to be adjusted for near, distance, constant use, the color and shade if they are tinted, and any other particular feature he desires.

Only by complying with the following specifications can lenses be considered acceptable.

1. Each lens should be clear white glass (except tinted glasses), free from bubbles, scratches, or any other defects.

2. The surface must be regularly smooth, properly polished, and show no faults by careful examination.

3. The power of the sphere and cylinder, the axis, and the prismatic power of each lens must all conform to the prescription as nearly as can be determined by available first-class means of examination.

4. Fused bifocal or trifocal segments must show no flowing.

5. The edges of segments must be sharply defined.

6. When there is a material difference between the shapes of the two corrective lenses or where perfect symmetry is not possible, necessary allowances and tolerances must be a matter of discrimination in each instance.

It would be wise for manufacturers to set up standards for first quality ophthalmic lenses which would be universally accepted as such, and that these lenses be labeled. It was suggested that standardization of the base, curves, and vertex refraction be included in the specifications for a first-class lens. If the lenses are sent out in an unfinished state, the dispenser should carry out the requirements to the end.

Other studies on lenses have included: The standardization of colored lenses in 1932 in collaboration with the United States Bureau of Standards, grading of lenses, specifications for noncorrective safety goggles and spectacles at the request of the Bureau of Ships of the Navy Department, polarized sunglasses, tinted lenses, and lenses for subnormal vision.

In regard to the latter study the field of vision of the Feinbloom telescopic lens was found to be no larger than that of the Kollmorgan lens. The Feinbloom telescopic lens was lighter, and no component of its doublet lens was found to have aspherical surfaces.

The American Committee on Optics and Visual Physiology has studied the Rodenstock Refractometer under the supervision of Dr. William F. Hughes. It concluded that the refractometer was as accurate as skiascopy with cycloplegia. However, without cycloplegia the Rodenstock instrument was inaccurate in 25 percent of cases, and was useless in the presence of cloudy media.

Orthoptic training and motor anomalies

A subcommittee on motor anomalies realized that if the supervision of orthoptic training was left to drift without properly informed direction many difficulties and abuses might ensue. Consequently, in 1936, it was suggested that a national committee on motor anomalies and orthoptic training be appointed. To facilitate this program the committee drew up proposed regulations for the examination of orthoptic technicians, and by-laws for a national committee on motor anomalies and orthoptics, as well as for a regional committee, and a syllabus of an approved course in orthoptic training was prepared. The outcome of these activities was the American Orthoptic Council which directs the training of technicians and governs orthoptic practices.

The subcommittee on motor anomalies, realizing the importance of nomenclature and classification and the difficulties encountered by the earlier committee (Dr. Howe, Dr. Duane, and Dr. Berens), asked Walter B. Lancaster to prepare a classification to be submitted to the committee for criticism. To him must go much of the credit for preparing an acceptable classification of motor anomalies. In 1932 he approached the problem on the basis that "every disease has an anatomical seat or location and every disease has a cause." This work was revised in 1943. Again in 1947 and 1949 revisions

were considered. As a result a subcommittee for the standardization of terminology for motor anomalies is now preparing a glossary of terms. Another glossary is to be compiled on the terminology of optics and visual physiology.

Research and investigations

One of the first research studies sponsored by the committee was on the standardization of test types and visual acuity tests for distance and near because of the need for uniform charts. This was carried out at the University of Michigan in 1930. The American Academy of Ophthalmology and Otolaryngology and the Knapp Memorial Fund of the Section on Ophthalmology of the American Medical Association provided limited funds for this research. Eventually because the committee could provide no further financial aid, the university assumed responsibility for the project.

In 1936, the committee was consulted concerning research problems involving the effects of variations in illumination. A proposed experiment was approved in principle and studies were carried on at Columbia University and Harvard University. An outcome was that the committee could recommend authoritative standards of illumination to such organizations as the National Council on Schoolhouse Construction.

The committee also acted as advisors for a study of the effects of reading at different levels of illumination.

In 1937, the American Committee on Optics and Visual Physiology, through its chairman, Walter B. Lancaster, proposed standards of illuminations for various tasks. These standards were revised in 1945 and in 1955 and in general slightly higher levels of illumination were proposed.

In 1940, there was a high rate of failure among aviation cadets after completion of training. In the hope of accounting for some of these failures, the committee was approached concerning a project to investigate the influence of aniseikonia on space perception. Consequently several hundred cadets were examined for aniseikonia.

At the request of the committee, Charles A. Bahn compiled the visual requirements, qualifying and disqualifying conditions, and official sources of information in all branches of the military services. These data were revised three times.

In 1943, the abuses of followers of the Bates and similar systems, which claimed to enable rejected men to pass visual requirements of the naval and air services, were brought to the attention of the committee. Action was taken toward enlightening authorities of the armed services concerning the value of such eye training.

Because of this situation the committee proposed that research should be carried on with the various methods of treatment by trained observers and that at first this study should be limited to myopia. The committee appointed a subcommittee on research on myopia. It believed that the claims made concerning the improvement of vision by means of visual training could only be confirmed or disproved by scientific research involving control and experimental groups. This study was supported financially by the Snyder Foundation. Although hampered by many problems, the report on this research is now in preparation. It suggests that motivation and the desire to see better are important factors in improvement of vision by visual training. Changes in refractive error as a result of such training were found to be negligible.

The retraining of the color blind was a controversial subject in 1946. Several methods had been credited with improving color vision. Since the Armed Forces-National Research Council Vision Committee sought reliable data on the situation, the American Committee on Optics and Visual Physiology requested that Commander Dean Farnsworth of the United States Naval Medical Research Laboratory conduct an investigation. Commander Farnsworth consulted groups of the most promi-

nent authorities in regard to corrective training of color blindness. It was decided that congenital color deficiency could not be remedied by the use of diet, medicine, training, or other treatment now known to science. Training a color deficient person to pass a color vision test defeats the purpose of the screening test. However, the ability to differentiate chromas might be modified by training.

A study of screening tests for color vision was instituted in 1954. Dr. Louise Sloan made a comparative investigation of the Dvorine pseudo-isochromatic plates, the H-R-R plates, the Rabkin, Ishihara, and Army Air Force plates. By 1955, numerous evaluation tests of the H-R-R plates were completed or in progress and the plates were being used extensively. They proved valuable in testing for the degree of recovery from retrobulbar neuritis. However, recent studies by Dr. Sloan have shown that the H-R-R plates may fail in detecting confusion of signal lights of small subtense and low luminance. In the future the committee proposes to continue its investigations of screening tests for color vision defects and to include lantern tests in the project.

The consideration of screening tests for eliminating eye defects in school children in 1938 revealed that certain tests recommended for use in schools were too rigorous, resulting in the unnecessary referral of children for eye examination. In 1947, a study of visual acuity of children was considered vital and it was suggested that this work be carried out at Washington University. The National Society for the Prevention of Blindness also participated in this investigation.

The first formal report of the results obtained from the vision testing of 1,215 St. Louis school children was presented at the annual meeting of the American Public Health Association in St. Louis in November, 1950. The report was published in 1954. In this study each student was tested with the following procedures by each of the examiners, who were technicians, nurses, and students' classroom teachers: Snellen test, Massachusetts vision test, Keystone View Company telebinocular test, American Optical Company sight screener test, Bausch and Lomb Orth-rater test, and near vision test.

From the data obtained it was evident that none of the vision-testing methods provides more than a rough screening process. In the study the different examiners obtained fairly consistent results on sixth-grade students with all of the tests, suggesting that it is not necessary for the tester to have elaborate training in the testing procedure. With first-grade students the same was true for the Snellen and Massachusetts vision test, but there was less consistency in the results obtained by the nurse and technicians from telebinocular and near vision tests at this age level.

In general the results obtained from the testing of the first-grade students are similar enough to sixth-grade students to support the belief that screening programs for beginning readers are worth doing. The way is still open for considerable improvement in procedures for screening elementary school children for visual defects.

In October, 1951, a special subcommittee was appointed to explore the possibilities of working out "the geometrical and decimal systems for designating visual acuity that would be standard for international use." The International Federation of Ophthalmologists, through Professor Nordensen, had asked for recommendations. The report was published by the Armed Forces-National Research Council Vision Committee Secretariat and also in THE AMERICAN JOURNAL OF OPHTHALMOLOGY.

Standardization of a decimal system for designating visual acuity for international use was not recommended. It was suggested that for the designation of visual acuity serious attention should be given at once to the adoption of the visual angle of resolution in minutes of arc of the component

parts of the test letters of the chart. Such a designation is a direct statement of what is actually measured. A geometric progression in the sizes of the letters of successive lines of the chart would be desirable but the progression rate should be chosen according to the particular needs for a given chart.

It was concluded that the present decimal system is understood generally, irrespective of the meter or foot systems. There would be nothing to be gained by adopting a standard decimal system.

The influence of the committee has reached out into the realm of publication not only of monographs but also of books. At the request of the committee, Dr. Paul Boeder translated von Tschermak-Seysenegg's *Introduction to Physiological Optics* because the committee believed that this most important and authoritative work should be available in the English language. The translation was a remarkable achievement and was accomplished at no cost to the committee.

One of the more recent studies concerned the influence of ultraviolet light upon dark adaptation. There was substantial evidence that ultraviolet light under ordinary visual conditions does not reach the retina in sufficient amounts to affect dark adaptation significantly.

Other studies have included iseikonic lenses for use by the Armed Services, standards for sight-saving classes, minimum standards of visual acuity for the War Department, visual standards for the United States Military Academy, fluorescent lighting, as well as its effect on the visual acuity of cadets at the United States Military Academy, beta irradiation, and computation of disabilities due to impaired motor function of the eyes.

This brief history of the American Committee on Optics and Visual Physiology illustrates the trend of its acivities through the years. Its projects have often been hampered by lack of funds. Nevertheless, its members have given unstintingly of their time and energies. The committee has sought to be an unbiased source of information to all seeking its counsel, to encourage scientific progress and to maintain high ethical standards within the profession as well as in fields related to ophthalmology.

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ENDOTHELIAL AND EPITHELIAL DYSTROPHY OF THE CORNEA*

Histopathologic study of a case

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Dewdroplike prominences of Descemet's membrane which may extend over all the posterior corneal surface are found as the earliest stage of endothelial and epithelial dystrophy. Vogt[1] called this early stage of such a primary degenerative condition "cornea guttata." In the later stages progressive edema and scarring of the stroma and dystrophy of the epithelium complicate the endothelial changes of the cornea. Before the introduction of the corneal microscope Fuchs[2] recognized this clinical entity in its advanced stages and called it "epithelial dystrophy." Later it became evident that the involvement of the corneal stroma and epithelium represent secondary changes following primary dystrophy of the endothelium (Vogt,[1] Kraupa,[3] Kirby,[4] Goar,[5] Friedenwald and Friedenwald,[6] Gifford[7]).

Relatively little is known about the origin and the pathologic nature of endothelial and epithelial dystrophy. The present study represents a description of the histologic findings in the cornea of a typical case of this condition utilizing a new histologic technique.

Case history

Mr. E. L., aged 59 years, was referred to the University Hospital in August, 1956, by Dr. J. H. Cooper of Toledo, Ohio. The patient had complained of reduced vision in his right eye on his first examination in August, 1955. Visual acuity, O.D., could be corrected only to 20/50 and J5 at that time. A nebular central corneal opacity involving epithelium, stroma, and endothelium was evident, and a diagnosis of Fuchs' dystrophy was made. A central corneal ulcer, with penetration into the anterior stroma appeared five days later. Healing occurred with antibiotic therapy, leaving a dense central leukomatous scar. Visual acuity was reduced to less than 20/80.

When first seen at the University Hospital, the patient's vision was recorded as 20/80−1, O.D., and 20/20−1, O.S. A protruding central corneal opacity measuring 3.0 by 4.0 mm. was seen to be a localized area of dystrophy with several intact subepithelial blebs causing the elevation. The stroma was densely clouded and thickened centrally, and the entire posterior corneal surface was studded with guttata. The anterior chambers were clear and examination of the ocular fundi demonstrated only a mild sclerosis of the arterioles.

The left cornea showed faint superficial clouding mainly below center, with a somewhat granular consistency. Extensive posterior guttata were identical to those seen in the right eye. A diagnosis of endothelial-epithelial dystrophy was made, and a penetrating keratoplasty was advised for the right eye.

The corneal surgery was performed on November 19, 1956, utilizing a 7.0 mm. button. The excised portion of the patient's cornea was retained for pathologic study. The postoperative course has been satisfactory to date.

Method of histologic examination

Horizontal sections of this corneal button were made on the freezing microtome. These sections were stained with the "panoptic" silver carbonate method of del Rio Hortega as described by Scharenberg and Zeman,[8] a method proven to be useful in staining the

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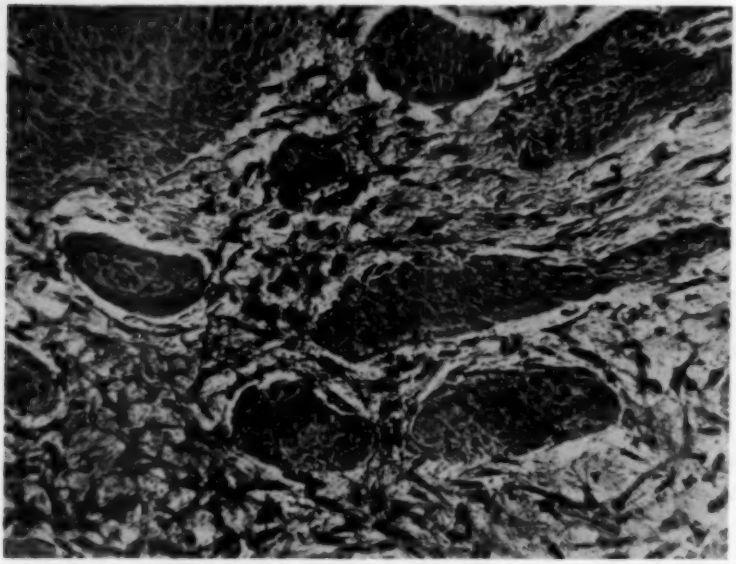


Fig. 1 (Wolter, Henderson, and Gates). Horizontal section through epithelium and proliferating stromal cells of the center of the corneal button. Islands of basal epithelial cells are surrounded by star-shaped, interconnected stromal cells. (Hortega method, photomicrograph, magnification ×250.)

epithelium, the glass membranes, the cells and the fibers of the stroma, and the endothelium of the cornea under normal and pathologic conditions (Wolter,[9,10] Wolter and Shapiro,[11] Wolter, Shapiro, and Whitehouse,[12] Scharenberg[13]). All illustrations presented in this paper are unretouched photomicrographs.

Histopathologic findings

The specimen represented a buttonlike piece of cornea measuring 7.0 mm. in diameter (fig. 4) as removed from the eye of the patient by the corneal trephine. The anterior surface of this corneal button, seen macroscopically, was irregular and white in its center.

The order of the histologic description follows the corneal layers from the anterior to the posterior surface.

1. Epithelium

In the center of the corneal button, the cellular arrangement and the thickness of the epithelial layer were very irregular. The epithelium was slightly wrinkled and the basal cells were not in contact with Bowman's membrane (figs. 1 and 2). Necrosis of epithelial cells in some areas had resulted in vesiculation and in the formation of some larger bullas. There was slight infiltration of the epithelium with polymorphonuclear leukocytes and lymphocytes. However, the epithelium was continuous and no epithelial ulcer was found. These changes were only found in an area of the central epithelium, measuring about 3.0 mm. in diameter, but this area was not sharply limited.

In the peripheral parts of the corneal button the epithelium was virtually normal and had remained in its normal close contact to the well-preserved Bowman's membrane of this region (fig. 12).

2. Bowman's membrane

In a central area of the corneal button of about 2.0 mm. in diameter no structures of Bowman's membrane were found. This membrane was replaced by proliferating stromal cells which were in direct contact

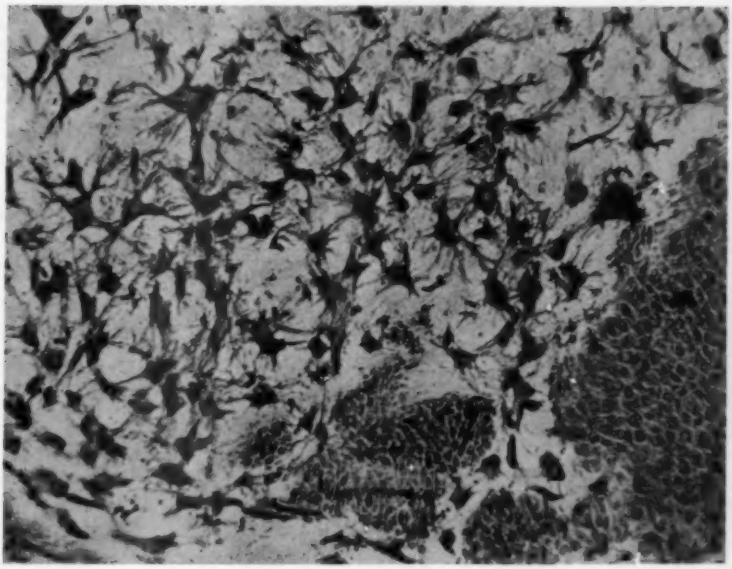


Fig. 2 (Wolter, Henderson, and Gates). An area of the newly formed layer of proliferating stromal cells which had replaced Bowman's membrane in the center of the corneal button. The star-shaped stromal cells are shown to be in direct contact with the basal layer of the epithelium. (Horizontal section, Hortega method, photomicrograph, mag..ification ×300.)



Fig. 3 (Wolter, Henderson, and Gates). Bowman's membrane (arrow) represented a wrinkled layer of homogenous substance in an area around the central defect. In the upper part of the picture, the newly formed layer of proliferating stromal cells is visible. (Horizontal section, Hortega method, photomicrograph, magnification ×300.)

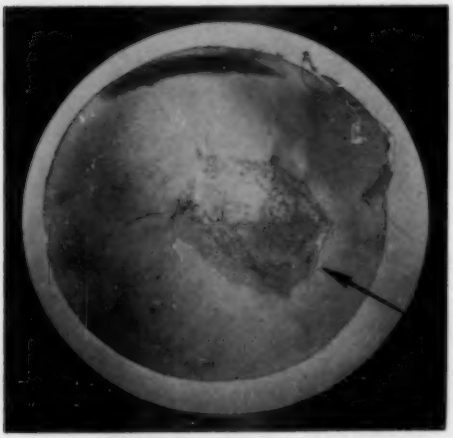


Fig. 4 (Wolter, Henderson, and Gates). Low-power view of a horizontal section of the whole corneal button through the corneal stroma. Arrow indicates the central area of stromal scar formation. (Hortega method, photomicrograph, magnification ×10.)

with the basal layer of the epithelium (figs. 1, 2, and 5). Bowman's membrane was present as a wrinkled layer of homogenous substance in an ear around this central defect. In this small region, however, the membrane also had no contact to the epithelium since stroma cells extended into the space between the basal epithelium and Bowman's membrane (fig. 3).

The peripheral region of the corneal button, a ring-shaped area of about 2.0 to 3.0 mm. in width, exhibited completely normal structures of epithelium, Bowman's membrane, and superficial stroma.

3. Stroma

The elements of the corneal stroma (stroma cells and lamellas) showed advanced pathologic changes in a central area of the button. The latter is clearly visible in Figure 4. This area showed severe degeneration and extended all through the depth of the central stroma. It measured about 3.0 mm. in diameter and had irregular, but relatively sharp limits toward the peripheral, virtually normal stroma. The pathologic changes were composed of degeneration of some stroma cells. Others showed hypertrophy and proliferation. These hypertrophic stroma cells (fixed cells) represented large, star-shaped cells with one or more nuclei and

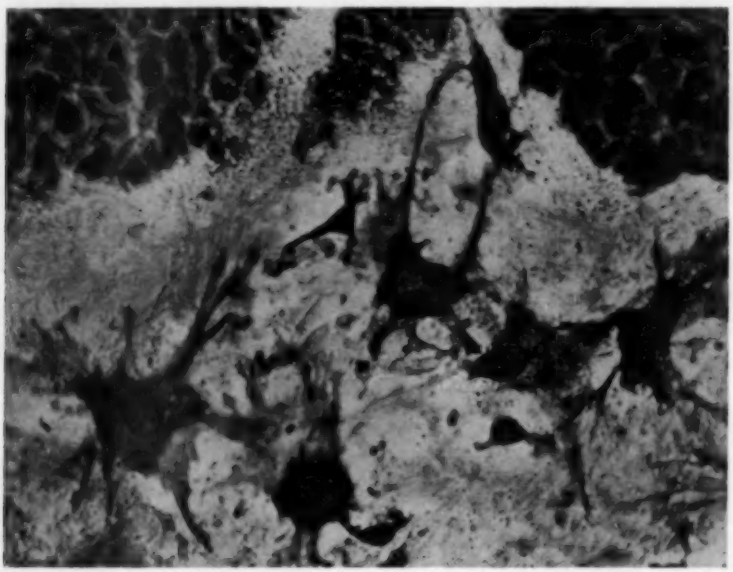


Fig. 5 (Wolter, Henderson, and Gates). High-power view of the proliferating stromal cells beneath the epithelium. (Horizontal section, Hortega method, photomicrograph, magnification ×800.)

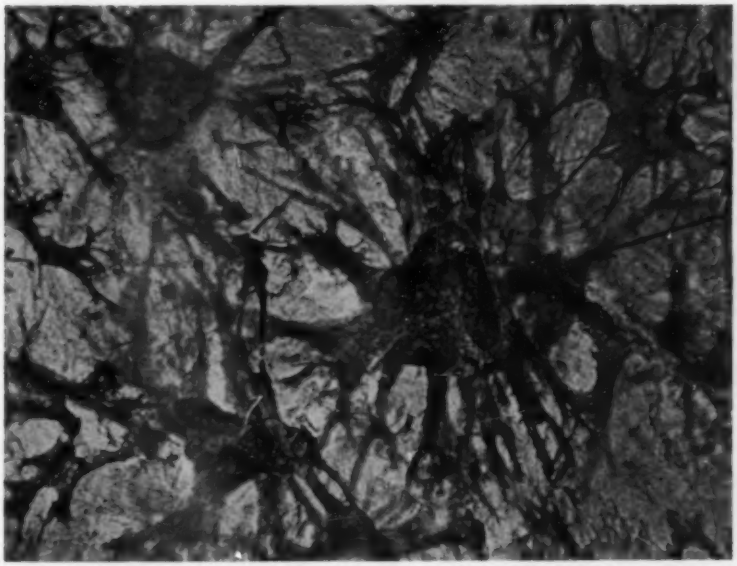


Fig. 6 (Wolter, Henderson, and Gates). High-power view of the proliferating stromal cells of the deeper layers of the central corneal stroma. A large star-shaped stromal cell (arrow) contains four nuclei. (Horizontal section, Hortega method, photomicrograph, magnification ×800.)

long processes (fig. 6; also figs. 1, 2, 3, and 5) and had invaded the subepithelial space of the missing central Bowman's membrane. Irregular fibers of swollen connective tissue had replaced the normally bandlike arranged corneal lamellas. There was edema and slight infiltration of leukocytes and lymphocytes of this central scarlike area.

The stroma of the peripheral region of the corneal button showed only some edema but no dystrophy of the stromal cells and lamellas.

No nerves could be stained in the severely degenerated central part of the stroma. The peripheral parts, however, contained nerve bundles and single nerve fibers of about normal appearance (fig. 11).

4. Descemet's membrane

Descemet's membrane exhibited the most impressive findings of this study. An immense number of round, wartlike excrescences covered all of the posterior surface of this membrane (figs. 7 and 8). There was no sharp limit between each of these bodies and the homogenous substance of Descemet's

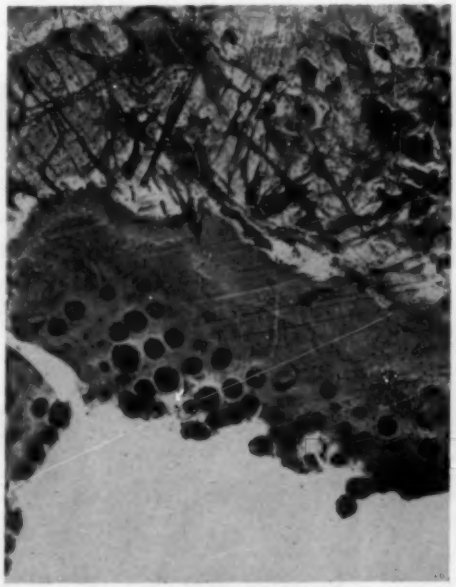


Fig. 7 (Wolter, Henderson, and Gates). An area of Descemet's membrane with numerous wartlike hyaline excrescences on its posterior surface. The upper part of the picture shows scarified corneal stroma. (Horizontal section, Hortega method, photomicrograph, magnification ×250.)

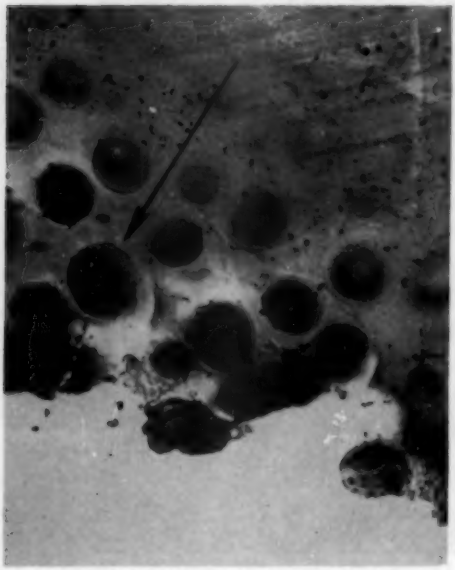


Fig. 8 (Wolter, Henderson, and Gates). High-power view of the posterior surface of Descemet's membrane which is covered with numerous round, wartlike bodies (arrow). The endothelium is missing in this section. (Horizontal section, Hortega method, photomicrograph, magnification ×800.)

membrane. The silver carbonate stain as well as other staining methods showed the same reactions in the substance of the excrescences and that of Descemet's membrane. The excrescences did not take a fat stain. They were densely distributed all over the posterior surface of Descemet's membrane in a diffuse but irregular pattern. All these bodies faced the anterior chamber. All represented single round bodies and none had become confluent with others of the wartlike bodies. Except for these bizarre formations on its posterior surface there were no other pathologic changes of Descemet's membrane. An impressive increase of thickness of Descemet's membrane was not noted.

5. Endothelium

The pathologic changes of the endothelium of this corneal button were actually the negative of those of Descemet's membrane. Where one of these wartlike bodies had developed on the posterior surface of Descemet's membrane, there was a round defect

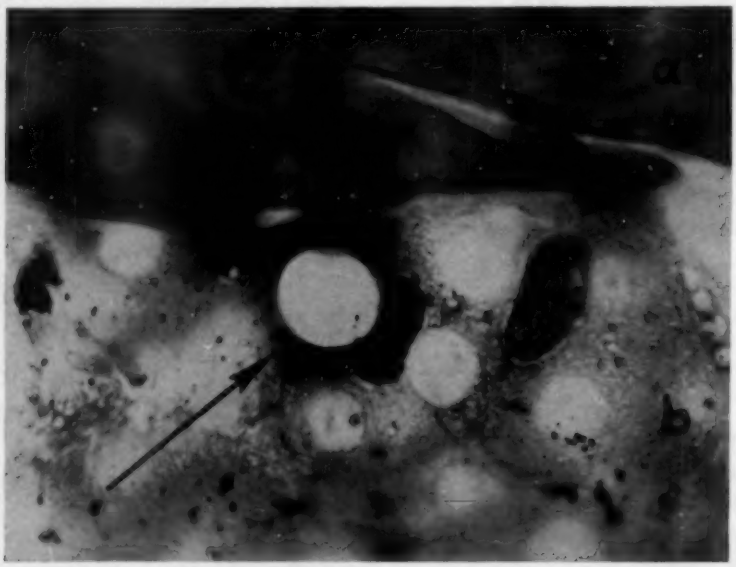


Fig. 9 (Wolter, Henderson, and Gates). Demonstrates a transitional section from Descemet's membrane (a) to the endothelium (b). The endothelium shows round defects and a perforation (arrow). The endothelium contains only very few nuclei. (Horizontal section, Hortega method, photomicrograph, magnification ×800.)

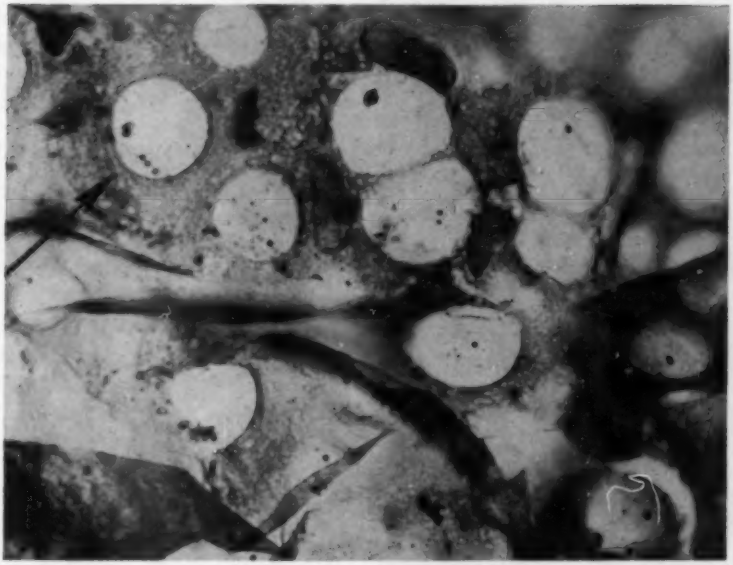


Fig. 10 (Wolter, Henderson, and Gates). Another area of the endothelium which exhibited round defects, perforations (arrow), and only very few cellular nuclei. (Horizontal section, Hortega method, photomicrograph, magnification ×800.)

in the endothelial layer (figs. 9 and 10). Most of these defects definitely did not represent through-and-through holes and a thin membrane of endothelial tissue covered the hyaline excrescences against the anterior chamber.

At some places, however, such a dividing membrane could not be found to cover the prominent bodies. Here, the hyaline bodies of Descemet's membrane must have been in direct contact with the fluid of the anterior chamber. This latter histologic finding of vir-

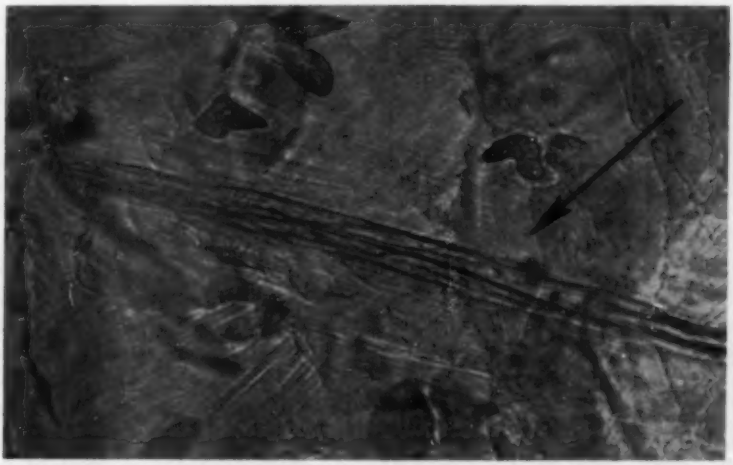


Fig. 11 (Wolter, Henderson, and Gates). Nerve bundle (arrow) in the corneal stroma of the peripheral part of the button. (Horizontal section, Hortega method, photomicrograph, magnification ×600.)



Fig. 12 (Wolter, Henderson, and Gates). Normal epithelium, Bowman's membrane, and stroma of the periphery of the corneal button. (Hortega method, photomicrograph, magnification ×250.)

tual perforations of the endothelium at the place of some prominent excrescences of Descemet's membrane of this cornea must be considered a fact and is certainly not an artefact.

There was also advanced degeneration of the endothelium. This was most clearly indicated by an extreme rarefication of the cellular nuclei of the endothelial cells (figs. 9 and 10). Compared to a normal endothelium, there were only very few nuclei left and many of these showed vacuolization or similar signs of degeneration. The posterior surface of the endothelium was diffusely covered with fine pigment granules.

It must be emphasized that both changes of the endothelium, the formation of round defects and holes, and the rarefication of cellular nuclei, extended over the entire posterior surface of the corneal button.

Comment

Previous authors have given excellent descriptions of the clinical features and course of the endothelial and epithelial dystrophy of the cornea. However, only few pathologic observations on this condition were published.

Fuchs[2] first recognized this corneal disease in its late stage and considered it a primary degenerative condition. He called the disease "dystrophia epithelialis." After the introduction of the corneal microscope, Vogt[1] called attention to the early stages of the disease which he described as "droplike endothelial prominences" of the central cornea (later Vogt called this "cornea guttata"). He found that these prominences histologically represent small round excrescences of Decemet's membrane which protrude into the endothelial layer. These bodies reminded Vogt of the Hassall-Henle bodies of the peripheral cornea. Kraupa[3] concluded that the dystrophy of the epithelium (Fuchs) probably begins and is caused by a progressive primary degeneration of the endothelium. Graves,[14] Kirby,[4] Friedenwald and Friedenwald,[6] and Gifford[7] reported further cases of clinical entity of endothelial and epithelial dystrophy. Kirby[4] gave an impressive picture of the arrangement of the droplike excrescences of the posterior surface of Descemet's membrane and emphasized the similarity of these bodies to the "drusen" of Bruch's membrane, the "Elschnig spheres" of the lens capsule, and to the "Hassall-Henle bodies" of the peripheral cornea.

Von Hippel[15] reported the pathology of an advanced case in which the endothelium was found to be completely missing. Goar[5] published a detailed clinical and histopathologic report. In his case, the author found Descemet's membrane "two or three times as thick as normal." The excrescences were so numerous in some places "that they appeared piled one upon another." No changes of the corneal stroma, Bowman's membrane, and the epithelium were reported.

The present study represents almost the first attempt at a complete histopathologic description of the changes of all corneal layers in an advanced case of the disease.

There were extensive degenerative changes of a central area of the epithelium, whereas the epithelium of the more peripheral regions was normal. Bowman's membrane was completely missing in a small central area and showed severe changes in a ring-shaped region around this central defect. Bowman's membrane was normal in the periphery of the button. The corneal stroma showed extensive degeneration in a relatively sharply limited central area. The peripheral stroma was nearly normal. The changes of the central stroma were composed of dystrophy of stroma cells, destruction of lamellas, edema, and slight infiltration. Descemet's membrane was continuous and not thicker than normal. However, its posterior surface was densely covered with numerous round excrescences of hyaline. There is no doubt that these hyaline bodies represent the histologic equivalent of the "dew droplike endothelial degenerations" as observed with the slitlamp. The endothelium showed a distinct decrease of the number of cellular nuclei (Irvine[16]). The hyaline bodies of Descemet's membrane obviously protruded into the endothelium and had resulted in round defects and real perforations. These perforations might be the cause of the development of the abnormal hydration and degeneration of the more superficial corneal layers. The slight infiltration of all layers is considered to be secondary.

Fuchs[2] observed that a loss of the corneal sensation to touch goes along with the epithelial dystrophy. In the present case we were unable to find any nerves in the degenerated center of the corneal button. The more peripheral parts of it, however, contained normal nerves. This finding indicates that actual destruction of the nervous elements in stroma and epithelium caused the hyposensibility.

Summary

The histopathologic findings in the cornea of an advanced case of endothelial and epithelial dystrophy (Fuchs) are reported. A silver carbonate technique of del Rio Hortega was used to visualize the pathologic changes. Degeneration of the endothelium and deposition of wartlike hyaline excrescences on Descemet's membrane were histologically demonstrated and are considered the primary changes in this entity. Edema and scarification of the more superficial corneal layers are assumed to be secondary.

University Hospital.

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DEMONSTRATION OF A COATING SUBSTANCE IN THE TRABECULAR MESHWORK OF THE EYE*

AND ITS DECREASE AFTER PERFUSION EXPERIMENTS WITH DIFFERENT KINDS OF HYALURONIDASE

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The presence of a hyaluronidase-sensitive barrier to the outflow of aqueous humor through the trabecular meshwork can easily be established by means of the perfusion technique. It is also suggested by the microradiographic studies of François, Neetens, and Collette.[5] Histologic evidence for such a barrier has so far been lacking. The purpose of this communication is to describe structural changes caused in the trabecular meshwork of various animals by different hyaluronidases.

MATERIALS AND METHODS

GENERAL

Eyes from cattle, sheep, and rabbits were used. The eyes from cattle and sheep were obtained from the slaughterhouse in ice-chilled saline. Before use the eyes were allowed to lie 15 minutes at room temperature. The rabbit eyes were enucleated immediately before the experiments. The perfusion technique was that of Bárány[1,2] using a horizontal burette.

Pairs of eyes belonging to the same animal were used except in sheep, where it was not possible to obtain paired eyes from the slaughterhouse. Of the pair, one eye was used as test eye and the other one served as control. Perfusion fluid was always cattle aqueous, which keeps the resistance stable a longer time than buffered saline.

The enzymes and venoms used were:

1. The testicular hyaluronidase Hyalas® from A. B. Leo, Hälsingborg, Sweden.
2. The staphylococcal hyaluronidase Hyason® from N. V. Organon, Oss, Holland.
3. The purified bee-venom Apicur® from Hoffmann-La Roche, Basel, Switzerland.
4. Snake venom: Crude Crotalus terrificus toxin.

Data about these hyaluronidases and units of activity are given by Bárány.[3]

Solutions of the hyaluronidases were injected during perfusion experiments into the anterior chamber through a separate needle. In the cattle and sheep eyes 0.3 ml. aqueous was drawn up into the syringe and mixed with 0.2 ml. hyaluronidase solution, after which 0.3 ml. was reinjected. This could not be done in rabbit eyes owing to their smaller anterior chamber. In these eyes 0.4 ml. hyaluronidase solution was instead washed through the anterior chamber. After the injection a counterpuncture was made.

After the perfusion experiments the anterior parts of the eyes were immediately cut meridionally and the eyes fixed in 10-percent neutral formalin for 24 hours. Replicas of the trabecular meshwork using a five-percent chloroform solution of methyl

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methacrylate were then made according to the technique of Vrabec[6] (which paper should be read before the present one, Am. J. Ophth., 44:7-12, 1957).

In order to avoid autosuggestion during the microscopic examination the following set-up was used. Each of the authors was presented with pairs of two slides, one with a replica from the test eye and one from the control eye marked in such a way as to give no clue which was from the test eye. The authors then had to decide independently which was the test eye. Only if both authors agreed on the correct answer the treatment was considered to have given a morphologically tangible result. It is realized that even if no real difference between the two preparations had existed but a decision had been forced the above situation would have occurred in 25 percent of the cases.

It must be borne in mind that in the replica method some errors of observation and experiment exist which can confuse the untrained observer. The eyes should be fixed fresh to avoid errors from autolytic and swelling processes. Reckless removal of the uvea in the preparation might destroy finer details.

The drying time should always be exactly two minutes in order to be sure to get equal qualities of the preparations. If drying is imperfect the water layer on the surface of the preparation makes the replica indistinct and might simulate a coating substance.

It has been found by experience that a five-percent chloroform solution of methyl methacrylate is most suitable for the replica technique. With a more dilute solution the more elevated parts of the trabecular meshwork might be insufficiently covered and with a more concentrated solution there is a greater chance to tear off the meshwork.

The second and third replica may show spots where the amorphous coating is torn off by the manipulation. These places, however, are clearly seen with sharp edges and will not confuse the observer.

In the microscopic observation where it is necessary to use an oblique illumination too much dimming can give confusing pictures. With the oblique light it is possible to see either a positive (raised) or a negative relief and it requires a little practice consistently to see a positive one, which is the most convenient for interpretation of the pictures. In the photomicrographs of this paper, the obliqueness of the illumination always was the same for test eye and control eye.

Findings

1. *Simple perfusion with injection of different hyaluronidases*

Cattle and sheep eyes

One eye was perfused with cattle aqueous until the maximum resistance was reached after which different hyaluronidases were injected. As soon as a full drop in the resistance had been established the eye was fixed. The control eye was perfused with cattle aqueous the corresponding time and then fixed.

The amount of hyaluronidase injected were three VRU* of Hyalas®, 0.14 mg. of the bee-venom Apicur®, or 0.24 mg. of snake venom. Hyalas® was dissolved in barbital-buffered saline pH 7.0 to 7.2. Apicur® is obtained dissolved in 30-percent glycerol. Before use it was dialyzed 20 hours at 4°C. in Visking cellophane bags against barbital-buffered saline pH 7.0 to 7.2. The snake venom was dissolved in cattle aqueous. Ten pairs of cattle eyes and five sheep eyes (three test and two control eyes) were used with Hyalas® and three pairs of cattle eyes with each of the venoms. A typical experiment is shown in Figure 1.

Rabbit eyes

The same type of experiment was performed on 10 pairs of rabbit eyes. The strength of the hyaluronidase washed through the anterior chamber was 2.5 VRU/ml. (four pairs) or 25 VRU/ml. of

* VRU = viscosity reducing units.

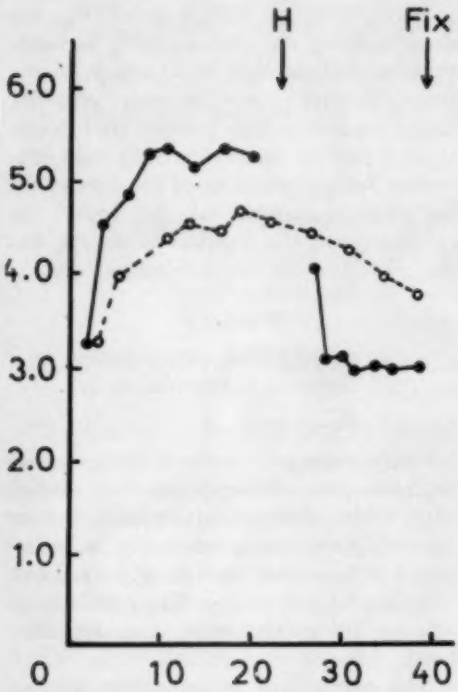


Fig. 1 (Berggren and Vrabec). *Simple perfusion experiment.* (Cattle.) Photomicrographs from the same experiment are shown in figure 3-a and b. Abscissa: Time in minutes. Ordinate: Resistance, expressed as time in minutes for 0.1 ml. to enter the anterior chamber. Test eye, full circles. Control eye, open circles. "H" indicates the injection of testicular hyaluronidase. At "Fix" the perfusion is stopped and the eye is immediately fixed in neutral formalin.

Hyalas®. This gives an immediate full drop of resistance and at least the larger dose may thus be regarded as being supramaximum. A typical experiment with 25 VRU/ml. is shown in Figure 2.

Results

Differences between the Hyalas®-treated eye and the control eye could be seen in eight of 10 pairs of cattle eyes and in nine of 10 pairs of rabbit eyes. In the rabbit eyes it was impossible to see if 2.5 or 25 VRU/ml. had been used in the test eye. In the sheep eyes differences were seen between the three test eyes on the one hand and the two control eyes on the other.

In the hyaluronidase-treated eyes the trabeculas showed sharper outlines and more detail, and the meshes between them seemed deeper. In certain places it was possible to count several layers of trabeculas in the depth of the meshes. The control eyes showed, in contrast, a more "coated appearance." The trabeculas and meshes had more diffuse borders and the depth of the meshes was smaller. In the treated eye the trabeculas sometimes could be seen to consist of fine fibrils. These were not visible as often in the control eyes. The impression was that in the test eye some substance had been removed thus making the structure more clearly visible. (See Figure 3-a and b, which shows replicas from the eyes used in Figure 1.)

Bee venom caused the same differences as Hyalas®, perhaps a little more pronounced, and noticeable in all the three pairs of eyes (fig. 3-c and d).

Similar results as with Hyalas® were also noticed in all the three pairs of eyes treated with snake venom (fig. 3-e and f).

In the cattle eye experiments, it was at-

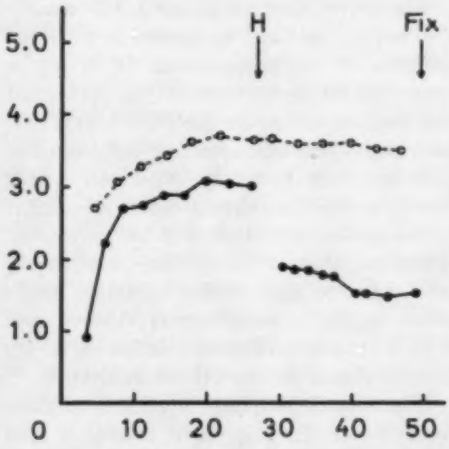


Fig. 2 (Berggren and Vrabec). *Simple perfusion experiment.* (Rabbit.) Abscissa: Time in minutes. Ordinate: Resistance, expressed as time in minutes for 0.01 ml. to enter the anterior chamber. Further notations as in Figure 1.

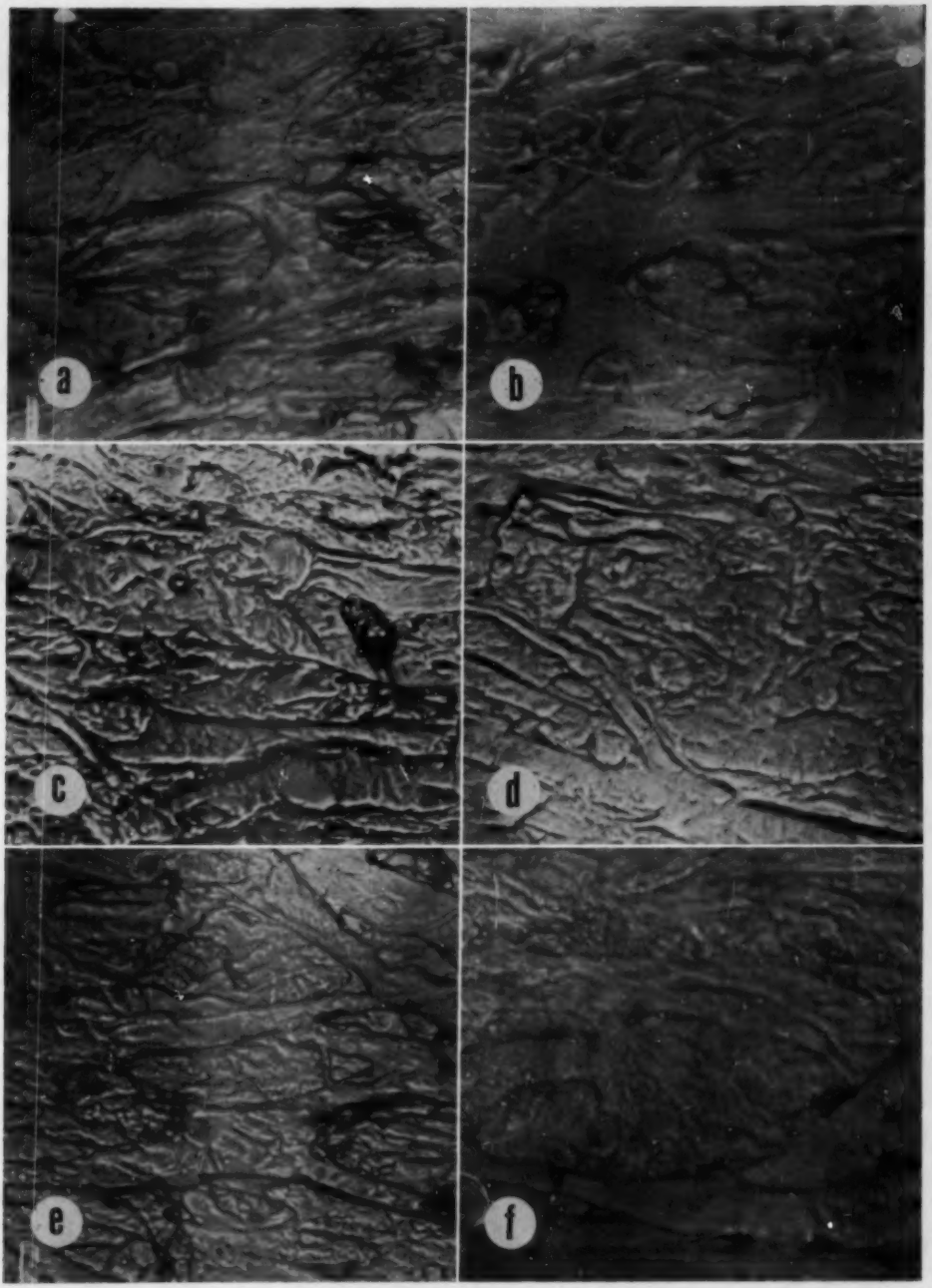


Fig. 3 (Berggren and Vrabec). Replicas of trabecular meshwork from cattle eyes subjected to simple perfusion experiments. (Magnification ×400.)

(a) Testicular hyaluronidase-treated eye. Sharp border of meshes, two or three levels of trabeculas visible.

(b) Control eye. Slanting borders of meshes, all details covered by a "coating substance."

(c) Bee-venom treated eye. Sharp outlines of trabeculas and meshes.

(d) Control eye. All contours indistinct.

(e) Snake-venom treated eye. The borders of the trabeculas are very clearly outlined and several levels are seen.

(f) Control eye. No distinct details are to be seen.

tempted to demonstrate that an enzyme effect that was just sufficient to cause a full drop in resistance was also sufficient to cause a morphologic change. It could be argued that one does not know how long the action of hyaluronidase went on after the bisected eyes were put into formalin. In order to see if a more prolonged action of the enzyme caused a further decrease in the coating substance, three pairs of eyes were used in a control experiment. The eyes were perfused until the maximum resistance was reached. The standard dose of Hyalas® was then injected into both eyes. One eye was fixed immediately after the full drop in resistance. The other eye was perfused an additional 60 minutes and was then fixed. Only in one pair was it possible to distinguish a further decrease of coating substance in the eye with the longer perfusion time. A prolonged action of the enzyme for at least one hour thus causes no striking effect on the coating substance.

2. *Massage effect*

It is known that slight mechanical trauma starts a process that breaks down the hyaluronidase-sensitive barrier, the so-called massage effect, Bárány.[1,2] We have looked for morphologic evidence of this effect.

Five pairs of cattle eyes were used. They were perfused until the maximum resistance was reached. One eye of each pair was then massaged in the following way. The perfusion was interrupted. The anterior chamber was punctured with an extra needle; 0.8 ml. aqueous was removed and then reinjected into the anterior chamber. This procedure was repeated five times. Two eyes were fixed immediately after the massage and three eyes after the full drop in the resistance caused by the massage had occurred. The control eyes were perfused with cattle aqueous over the corresponding interval of time and then fixed. Typical experiments are shown in Figure 4-a and b.

Results

Only small differences could be seen between test and control eyes in the three pairs that were fixed after a full drop in resistance had been established. These differences were of the same kind but not as pronounced as those noticed after hyaluronidase injection.

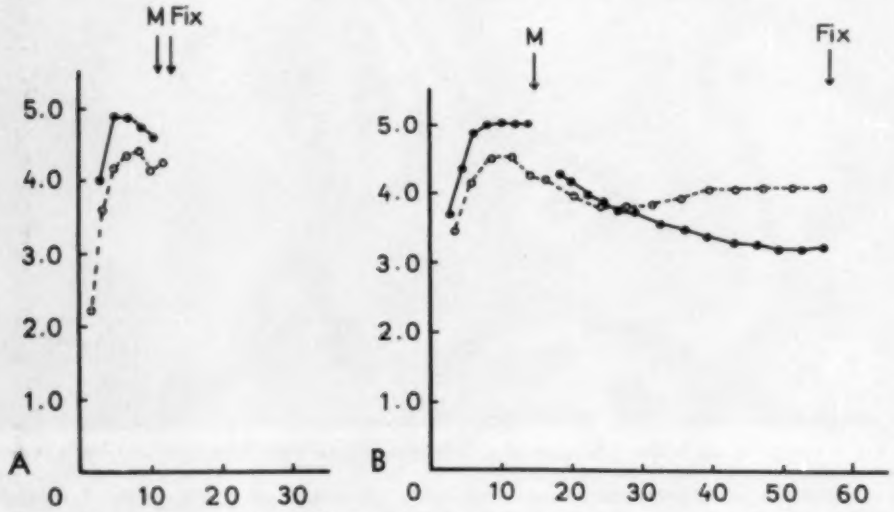


Fig. 4 (Berggren and Vrabec). *Massage effect.* (Cattle.) Abscissa: Time in minutes. Ordinate: Resistance, expressed as time in minutes for 0.1 ml. to enter the anterior chamber. Test eye, full circles. Control eye, open circles. "M" indicates massage and "Fix" stop of perfusion of the eye.

In the two pairs of eyes where the test eye was fixed immediately after the massage no difference could be seen between test and control eye.

3. *Restitution*

If the hyaluronidase-sensitive barrier is broken down in vivo the resistance of the chamber angle returns gradually to the normal level in a few hours. This recovered resistance is, however, almost hyaluronidase-insensitive. By some unknown mechanism the eye seems to have compensated for the lost hyaluronidase-sensitive component (Bárány[4]). We have tried to find the morphologic change underlying this phenomenon.

A. Hyason® 0.25 VRU in 0.05 ml. of 0.9-percent NaCl was injected into the anterior chambers of both eyes of two living rabbits, using a very fine needle. In one rabbit 0.05 ml. of 0.9-percent NaCl was injected instead into both eyes. After four hours the eyes were enucleated and perfused with cattle aqueous until the maximum resistance was reached. Hyalas® 25 VRU/ml. was then washed through the chamber of one eye of each pair and the eye fixed when a steady resistance was obtained. The control eye was perfused with cattle aqueous the corresponding time and then fixed. A typical experiment is shown in Figure 5. It is seen that renewed application of hyaluronidase has little or no effect.

B. Hyason®, as above, was injected into one eye of two living rabbits. Into the other eye 0.9-percent NaCl was injected instead. After six hours the eyes were enucleated and fixed without perfusion.

C. Hyason® and 0.9-percent NaCl were injected as in (B) in seven living rabbits. After 24 hours the eyes were enucleated and perfused with cattle aqueous until a steady resistance was reached. The eyes were then fixed. In two pairs of eyes the specimens were fixed without previous perfusion. In the five perfused pairs of eyes the ratios of the resistance between the Hyason®-treated eye and the NaCl-treated eye were calculated.

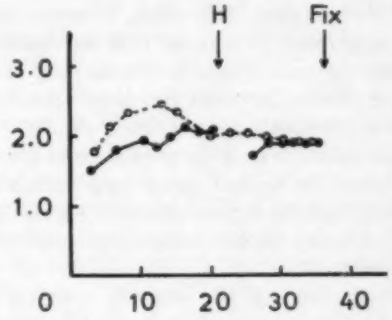


Fig. 5 (Berggren and Vrabec). *Restitution experiment.* (Rabbit.) Abscissa: Time in minutes. Ordinate: Resistance, expressed as time in minutes for 0.01 ml. to enter the anterior chamber. Bacterial hyaluronidase was injected four hours earlier into

The mean ratio was 1.05. There was thus complete recovery of the resistance of the chamber angle.

Results

A. In the only pair which received NaCl in vivo there was a marked difference between the hyaluronidase-treated and the control eye, as in a simple perfusion experiment. This showed that an injection of NaCl into the anterior chamber four hours before the perfusion had no decisive influence on the replica picture of the trabecular structure. In accordance with the results of Bárány[4] the hyaluronidase-sensitive barrier is still not rebuilt four hours after the injection of bacterial hyaluronidase and no further drop occurs after a new injection of hyaluronidase. This corresponds nicely with the findings in the replica studies, where no difference in structure could be seen between the test eye which had been exposed to hyaluronidase a second time and the control eye which had only been injected in vivo.

B. These two pairs of eyes which had been fixed without perfusion six hours after an intracameral in vivo injection of Hyason® or NaCl respectively showed the same difference between enzyme-treated and control eye as was seen in simple perfusion experiments. Besides, there was a suggestion of "beaded" appearance (see later) in both test

and control eyes. This effect, however, was so weak that it was at first overlooked. When the eyes where restitution had been going on for 24 hours had been examined and showed this picture more clearly, the slides from the six-hour eyes were re-examined and the beaded appearance could also be established in these slides. We were not able to find these changes in four-hour experiments.

C. In four of five pairs of eyes where Hyason® had been injected into one eye 24 hours earlier, the test eyes were still seen to have a decreased coating though not as pronounced as in simple perfusion experiments. In one pair of eyes no difference in coating was seen. A new difference, however, was noticed in all pairs. The surfaces of the trabeculas of the test eyes were no longer smooth but showed a beaded appearance (fig. 6-a and b). In the control eyes this change was also present but much less pronounced. The two pairs of eyes fixed without perfusion showed the same picture.

Discussion

In comparing the replica slides of test and control eyes it proved important to notice especially the depth and sharpness of the meshes and the fibrillary structure of the

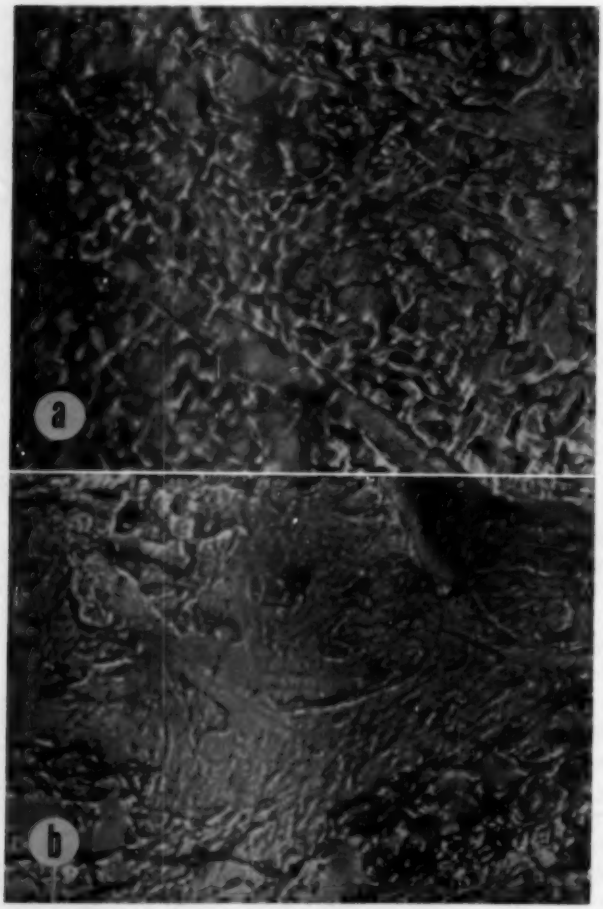


Fig. 6 (Berggren and Vrabec). Replicas of trabecular meshwork from rabbit eyes subjected to restitution experiment. (Magnification ×400.)

(a) Bacterial hyaluronidase injected 24 hours earlier. "Beaded" trabeculas.

(b) Control eye. NaCl injected 24 hours earlier. A beaded appearance is indistinctly seen.

trabeculas. In studying the replica one must study the whole of it to get a general impression and not only select certain suitable places. The technique of distinguishing differences is, however, not easy and requires a great deal of experience of the observer. The differences were best seen in the anterior part of the trabecular meshwork with its broader trabeculas. In the posterior part the fibrillar structure was clearly seen already without enzyme treatment and alike in both test and control eyes. If the coating substance is really lacking in the posterior part of the meshwork or the observation depends on this part being more vulnerable and thus more easily destroyed during the preparation cannot be decided.

In the simple perfusion experiments with testicular hyaluronidase the two observers were able to identify the hyaluronidase-treated eye in eight cases of 10 (cattle) and in nine cases of 10 (rabbit). With the procedure used the probability that the right answer is picked by chance in eight cases out of 10 is less than 0.001. Morphologic changes in the trabecular meshwork after hyaluronidase treatment are thus established beyond doubt with the replica method.

We have observed the same morphologic changes with a decrease in the coating substance of the trabecular meshwork with four different kinds of hyaluronidase. It is thus probable that at least a part of the coating substance is hyaluronic acid or a very closely related mucopolysaccharide. In perfusion experiments with the same four kinds of hyaluronidase as used in the present experiments Bárány[3] found them all to cause the same decrease in the resistance to flow through the anterior chamber angle. Hence it seems plausible that the reduction of resistance caused by hyaluronidase in perfusion experiments is due to the decrease in coating substance in the trabecular meshwork revealed by the replica technique.

In restitution experiments (Bárány[4]) hyaluronidase is injected in vivo into the anterior chamber. The resistance is then measured in vitro at varying times after the hyaluronidase injection.

The resistance might be considered to be composed of different components, one of which is hyaluronidase-sensitive. Immediately after the injection of a hyaluronidase the resistance is reduced, owing to the fact that the hyaluronidase-sensitive part is broken down. After breakdown with testicular hyaluronidase it is partly rebuilt in 24 hours. This fits with our observation of a smaller degree of "uncoating" than in acute experiments. The total resistance, however, returns to a normal level much earlier.

Bárány states that as early as four hours after bacterial hyaluronidase the resistance has reached the normal height without reappearance of hyaluronidase-sensitivity. This agrees with our finding no hyaluronidase-sensitive coating after four hours of restitution. Thus the remaining part of the resistance has increased or a new component of resistance has arisen, compensating for the loss of the hyaluronidase-sensitive part. Furthermore, if only one eye is hyaluronidase-treated, the other one serving as a control, the control eye is not unaffected by the changes of resistance in the test eye (Bárány[4]). The complete resistance is kept at normal level but the hyaluronidase-sensitive part is somewhat reduced. This speaks for an as yet unexplained sort of consensual reaction.

Replicas from the restitution experiments show that after 24 hours a new picture in the form of a beaded appearance is seen both in the test eye and, to a less extent, in the control eye. Even in six-hour experiments the same change is seen, though less pronounced.

The beaded appearance might be caused by an uneven secretion of a new layer of coating substance or a swelling of either cells, collagen bundles, or ground substance of the trabeculas. In order to determine what factor might be responsible we have studied the trabecular meshwork with ordinary histologic methods in paraffin sections.

The meshwork from one eye where restitution had been going on for 24 hours was studied. A beaded appearance of the trabeculas was seen here too. The collagen bundles were a little swollen but the beaded appearance was seen to be due to a swelling of the ground substance between the bundles. The order of magnitude of the "beads" was about the same as that in the replicas. These changes could not be seen in the meshwork from an untreated eye. The cells in the meshwork were alike in both the test eye and the untreated eye.

These results are only preliminary but can give a hint as to the factors underlying the new picture found in restitution experiments. An assumption that the beaded appearance has something to do with the compensating mechanism tending to keep the resistance at a normal level fits rather well with the physiologic evidence. Even the unexplained "consensual" reaction has its counterpart in the replicas. On the other hand, beading cannot be the only mechanism involved in recovery of resistance, since resistance recovers in four hours, at which time beading still is minimal.

Summary

With hyaluronidases of different kinds the existence of a hyaluronidase-sensitive barrier in the trabecular meshwork has been established in perfusion experiments on eyes from cattle, sheep, and rabbits. The trabecular meshworks of these eyes have been further examined by means of the replica technique.

It has been demonstrated that in the trabecular meshwork there is a coating substance that can be removed by hyaluronidases. Mechanical trauma, which is known to start a process which breaks down the hyaluronidase-sensitive barrier, also causes a reduction in this coating substance.

In eyes where the hyaluronidase-sensitive barrier has been broken down in vivo but the resistance has returned to normal, there were structural changes possibly indicating swelling of the trabeculas. This might be due to a compensating mechanism maintaining the resistance at a normal level.

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VIABILITY OF STORED CORNEA OF THE RABBIT*

On the chorioallantoic membrane of the chick

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In all methods of storage of donor corneal tissue, the viability of cells continues to be the chief focus of attention, since most surgeons believe that a living graft is essential for final success.

Billingham and Rycroft[1] studied viability of stored tissues by grafting rabbits' cornea onto the chest wall of the same animal. Epithelial cells showed proliferation by this method up to one month of storage at −79°C.

In earlier studies of viability of stored cornea, it was shown by us[2] that both epithelial cells and fibroblasts could be grown in tissue culture for varying periods, depending upon the conditions of storage. Those tissues stored at 4°C. in the ordinary refrigerator remained viable up to three weeks in aqueous vapor and up to one month in liquid paraffin, in spite of gross cloudiness which appeared toward the end of the second week. Tissues pretreated with glycerine and subsequently frozen were viable only after one and one-half hours of storage if the freezing had been rapid, but were viable up to three months when freezing had been less rapid.

In the present study, the chorioallantoic membrane of the chick embryo was chosen for culturing the cornea because it offered some advantages over tissue cultures. Evidence of viability of the tissues could be seen grossly by vascularization and survival of the graft. Histologically, we used as the chief criterion of viability the healing of preplaced epithelial wounds in the graft. The presence of mitotic figures, and of typical changes in the epithelium following inoculation with the herpes simplex virus, were also used as criteria (according to the method of Kirber and Kirber[3]).

Methods and Materials

Storage of eyes was carried out at 4°C. in liquid paraffin and in aqueous vapor, and at −79°C. following pretreatment with glycerine for one hour, freezing the tissues slowly in the dry-ice chest. As a control, fresh corneas were used on the one hand, and "dead" corneas on the other. The latter tissues were made nonviable by placing them in a solution of five-percent formalin or of 90-percent alcohol for 24 hours.

When eyes were removed from storage, they were placed in a solution containing penicillin and streptomycin for 20 minutes. Lamellar grafts, nine mm. in diameter, were cut from each cornea. A number of full-thickness grafts with intact Descemet's membrane were taken for comparison. Multiple scarifications through the epithelium were carried deep into the stroma, and each graft cut into two equal parts. Each half cornea was grafted onto separate egg membranes and one of these portions was infected with pooled, egg-adapted herpes simplex virus.

For cultivation of the grafts, 10-day fertile hens' eggs were used. The chorioallantoic membrane was dropped by the false air-sac technique and a window cut over the area. Grafts were placed upon large blood vessels, one portion of the corneal tissue for each egg, and the window closed with Scotch tape. Incubation was carried out for 72 hours at 37°C., after which the cornea with attached egg membrane was dissected out, placed in five-percent formalin and studied histologically.

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Results

At the time of harvesting, three days after grafting onto the egg membrane, living grafts could be differentiated from dead grafts by the gross appearance. A living graft was swollen, bluish in color, and opaque. Due to the adhesion of the graft to its bed, it could only be separated from the egg membrane with difficulty, and, in peeling it off, there was bleeding from the rupture of invading blood vessels. The adhesion was considerably less firm with full-thickness grafts, since Descemet's membrane apparently created a barrier against the cellular and vascular invasion from the egg membrane. "Dead" grafts failed to adhere to the chorioallantois, turned yellow, became necrotic, and could be easily peeled off from the egg membrane without any bleeding.

Microscopically, chick cells and blood vessels freely invaded the structure of the living graft, firmly anchoring it onto the egg membrane. Dead tissues were free from cellular or vascular invasion. The stroma of dead grafts looked pale and homogenous compared to the bright lamellar and cellular appearance of living tissue.

In living grafts, at the junction of the two tissues, the chorionic epithelium was often lost, or recognized only by the presence of epithelial pearls. The chorionic epithelium could be distinguished easily from corneal epithelium by the character of the cells. Rarely was there any tendency on the part of the egg-membrane epithelium to grow over the corneal surface when corneal epithelium was absent.

TABLE 1

VIABILITY OF CORNEAL EPITHELIUM ON THE CHORIOALLANTOIS OF CHICK

	Period of Storage (weeks)	Growth of Epithelium (percentage)
1. Fresh corneal tissue		
Without Descemet's membrane		90
With Descemet's membrane		10
With coverslip between the graft and bed		0
2. Stored corneal tissue at 4°C.		
Liquid paraffin	1	90
Liquid paraffin	3	80
Aqueous vapor	1	85
Aqueous vapor	2	75
3. Stored corneal tissue at −79°C. (pretreated with glycerine and slow-frozen)		
	1	85
	6	70
	12	65
4. Dead corneal tissue		0

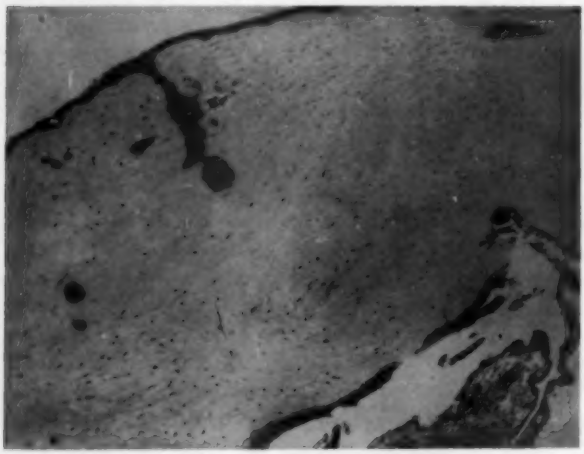


Fig. 1 (Basu, Miller, and Ormsby). Proliferation of epithelial cells into corneal wound. Tissue stored for 17 days in liquid paraffin at 4°C.

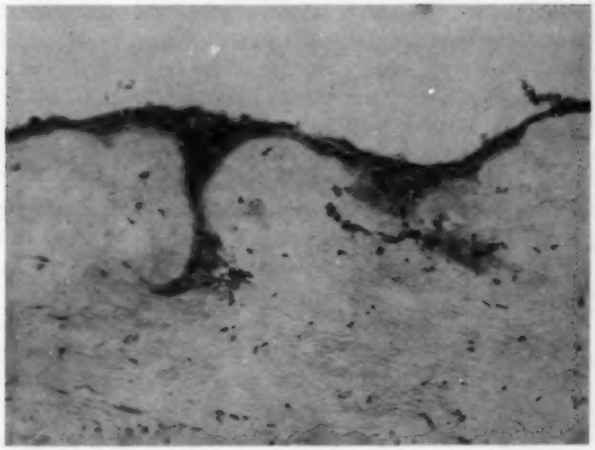


Fig. 2 (Basu, Miller, and Ormsby). Proliferation of epithelial cells into corneal wound. Tissue stored for three months at —79°C.

Following removal from storage, all corneas had intact epithelium before they were planted onto egg membranes, but epithelium was sometimes absent after harvesting, having been lost during incubation.

Each cornea was scarified deeply into the stroma from the epithelial surface before grafting onto egg membrane. In cases where the epithelium was intact, these scarified areas were found to be filled up by the proliferation of corneal epithelial cells (figs. 1and 2). This growth of epithelium was absent in grafts which failed to form adhesion with the egg membrane, or in the grafts which were dead. Mitotic figures were further evidence of viability when they could be seen, and were further observed in both fresh and stored grafts (fig. 3). In those corneas which had been inoculated with the virus of herpes simplex, only a few fresh and preserved grafts (fig. 4) showed inclusion bodies in the epithelial cells. It was believed that this last method was not a good one for the demonstration of viability in this type of procedure.

A few corneas lost the epithelium during the incubation period on the chorioallantoic membrane, but even in these the corneal stroma looked exactly like those which retained the epithelium. Most of the deep-



Fig. 3 (Basu, Miller, and Ormsby). Epithelial mitotic figures in seven-day frozen-stored cornea.

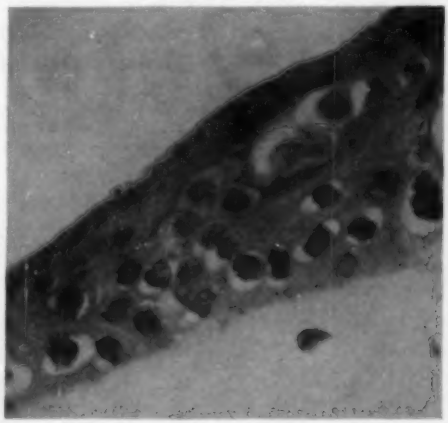


Fig. 4 (Basu, Miller, and Ormsby). Epithelial edema, Lipschutz bodies, and giant cells following inoculation with herpes simplex virus. Tissue stored for seven days at —79°C.

frozen tissues which were stored longer than three months lost their epithelium after planting onto the egg membrane. However, the stroma appeared normal, and was infiltrated with blood vessels and cells from the egg membrane. Since our criterion of viability was the growth of epithelium into the scarified area, we did not include this group in the assessment of the results, though they appeared to be viable otherwise.

Discussion

In this study of viability, the chorioallantoic membrane of the embryonated hen's egg has proven a superior method for the cultivation of corneal tissues. By this method we have confirmed our previous findings in tissue cultures by gross and microscopic observations of tissues grafted onto egg membranes.

This method seems preferable to the in vivo method of Billingham and Rycroft,[1] in so far as the repair of epithelial wounds depended upon viable epithelial cells in the central area of the grafted cornea. By the method of Billingham and Rycroft, viability was assessed upon an outgrowth of peripheral cells from the edge of the graft.

This method of grafting cornea onto egg membrane has the additional advantage of permitting one to carry out a large number of procedures economically. Thus our results are based upon approximately 500 separate experiments.

Summary and Conclusion

1. Rabbit corneas stored at 4°C. in aqueous vapor and liquid paraffin, and at −79°C. following glycerine pretreatment, were deeply scarified on the epithelial surface following removal from storage and placed on the chorioallantoic membrane of 10-day fertile hens' eggs.

2. Gross evidence of tissue viability was present in living grafts which appeared normal and became vascularized from the chick membrane. This gross appearance corresponded closely to the histologic evidence of epithelial viability.

3. Epithelial repair occurred in grafted tissues which had been stored at 4°C. up to two weeks in aqueous vapor and up to three weeks in liquid paraffin. Tissues, pretreated with glycerine and deep-frozen, showed evidence of viability of epithelial cells for at least three months of storage.

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VISUAL LOSS FOLLOWING MITRAL COMMISSUROTOMY FOR MITRAL STENOSIS*

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The popularization of the operation of mitral commissurotomy for mitral stenosis, with its attendant intracardiac manipulation, has introduced another cause for arterial embolization.

In many cases of mitral stenosis, thrombi fill the left auricular appendage through which the finger is placed to correct the valvular lesion. These thrombi may be old and adherent in which case the danger of embolization is minimal, or they may be fresh and poorly attached with a tendency to break off and lodge in either the cerebral or peripheral arterial tree. Patients with long-standing mitral valvular disease often have calcium deposits on the valve leaflets and during commissurotomy one or a shower of emboli may be dislodged into the peripheral circulation. The calcific emboli being small are more likely to occlude smaller vessels.

In a series of 901 mitral commissurotomies reviewed by Tropia,[1] there were a total of 28 emboli, 19 were cerebral and nine were peripheral. The latter included two at the aortic bifurcation, five common femoral, one axillary, and one common carotid.

Of 12 cases of cerebral embolism, following mitral commissurotomy reviewed by Bailey,[2] five presented evidence of predominant involvement of the right side of the brain and seven of the left side. Three had bilateral involvement. All patients demonstrated definite neurologic changes indicative of cerebral embolism, although six did not regain full consciousness postoperatively. The majority had signs and symptoms that suggested involvement of the middle cerebral artery or its branches. Hemiplegia was present in nine cases, and partial quadriplegia in three. In addition these patients showed a prolongation of the unconscious state after surgery, aphasia, facial weakness, and abnormal reflexes such as a Babinski sign and ankle clonus. Eight deaths resulted among the 12 cases, but no mention was made of any visual disorders in the survivors.

In a case reported by Balton,[3] et al., at post mortem, the patient showed a calcified embolus at the junction of the left middle cerebral artery with the posterior cerebral artery and sections of the left cerebral hemisphere, revealing two large areas of softening. One corresponded to the area supplied by the middle cerebral artery which involved the medial aspect of the temporal lobe and the entire length of the internal capsule and nuclei on either side. The other area of softening was in the occipital lobe and seemed to invlove all of it. No mention was made of any visual disturbance in this case because the patient failed to regain consciousness postoperatively.

Microscopic sections of the middle cerebral artery showed the lumen to be occluded by a thrombus, while sections of the left internal capsule and occipital lobe showed areas of infarction, with edema and perivascular and intracerebral hemorrhage.

Treatment of this condition in the cases reported by Bailey[2] consisted of repeated stellate ganglion blocks, occasional dehydration, mild sedation, and vasodilators, all of which were found to be of relatively small benefit.

CASE REPORTS

CASE 1

A 29-year-old white man developed a mitral stenosis following an attack of rheumatic fever at the age of 15 years. After that he had attacks of cardiac decompensation with dyspnea and ankle edema which were treated with digitalis preparations. However, because the symptoms persisted and

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he had had attacks of hemoptysis, surgery was advised.

Preoperatively, the blood pressure in the right arm measured 120/78 mm. Hg and in the left 120/80 mm. Hg.

Physical examination was noncontributory excepting for cardiac enlargement with a loud rubbing diastolic murmur at the apex. Blood cultures were negative. Although not seen by an ophthalmologist, the eyes were normal and the patient was not exhibiting visual difficulty.

Following the mitral commissurotomy the patient exhibited a stormy postoperative course. On the evening of the operation, all peripheral pulse beats were recorded as present and normal. The visual acuity was not tested but it was observed that the right pupil was dilated and fixed to light and a bilateral Babinski sign was present.

The blood pressure measured 120/72 mm. Hg, temperature was 106°F. and a paresis of the right arm and leg was noted.

Several hours later the patient was restless and unable to speak. The right-sided hemiparesis was about the same. Clotting time was eight minutes and heparin (50 mg.) was administered every six hours.

Later the same evening, the patient continued to become more restless and agitated and developed a right facial palsy. At this time all the peripheral pulses were present and the patient did not respond to pin-prick on either side of the body.

Twenty-four hours postoperatively, the patient's condition was essentially unchanged, in that he was still semistuporous. Although he attempted to talk, he could not do so. Forty-eight hours postoperatively his condition remained unchanged. At 72 hours, the right pupil was still dilated and fixed, the right facial paresis was still present and the patient was still aphasic. However, he was now able to move all extremities.

On the fourth postoperative day, it was noted that his understanding was much improved. On the sixth day, it was recorded that, although the patient apparently could see and hear, he did not comprehend; and although he tried to speak, he was not rational. On the 12th postoperative day, it became apparent that the patient was blind. On the 14th day, the patient stated that the "only difference" with his eyes opened or closed was that with his eyes open, he saw "more light."

Examination of the patient at this time revealed an "unawareness" and "lack of concern" over his inability to see, such as that described in a person with occipital lobe blindness. The patient was barely able to perceive light in both eyes but no light projection was present. Both pupils were widely dilated measuring about 10 to 11 mm. in each eye. Direct reaction to light revealed that each pupil contracted only one to two mm. and then quickly returned to its original state of dilatation. There was almost no consensual reaction to light in either eye. Tactile tension was normal and both fundi were normal. The fundi showed no edema or atrophy of the discs, no attenuation of the retinal arterioles, no venous engorgement, and no retinal edema, exudates, or hemorrhages. No cherry-red spot was present in either vascular area. Examination four and six weeks postoperatively revealed no change in the clinical picture or ocular findings. At the eighth postoperative week the patient was able to perceive light in either eye, and no change had taken place in the ocular findings.

At the 10th postoperative week the visual acuity in the right eye had returned to 20/100 plus and in the left eye to 20/200. The pupillary size was now reduced to 4.5 mm. in each eye and the response to light was now more brisk and the pupils contracted to a size of about 2.5 mm. from which they sluggishly dilated to a size of approximately 4.0 mm.

The fundi were now considered normal, although in the left eye there was some suggestion of temporal pallor. The patient also appeared to be more aware of his condition than at any time previously. The visual fields are shown in Figures 1 and 2.

By the eighth postoperative month the pupil size and reaction remained unchanged and the visual acuity in the right eye had improved to 20/50, and in the left eye to 20/70. The fundi were normal and confrontation with the visual field revealed a severe generalized contraction.

By the 10th postoperative month, vision had returned to 20/20 in each eye uncorrected and the visual fields (figs. 3 and 4) revealed a severe generalized contraction with some increase in the size of the superior altitudinal field of each eye.

CASE 2

A 40-year-old white man had been followed in the cardiac clinic for many years because of a mitral stenosis following a rheumatic carditis. Because of several attacks of cardiac decompensation which could not be controlled with digitalis, sur-

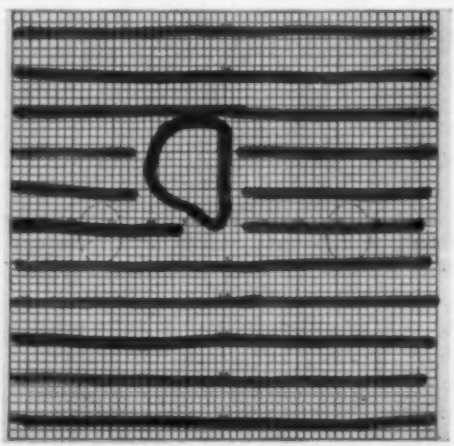


Fig. 1 (Alfano, Fabritius, and Garland). Right eye, 10/1,000 white target, vision, 20/100 +. *Case 1* at 10th postoperative week.

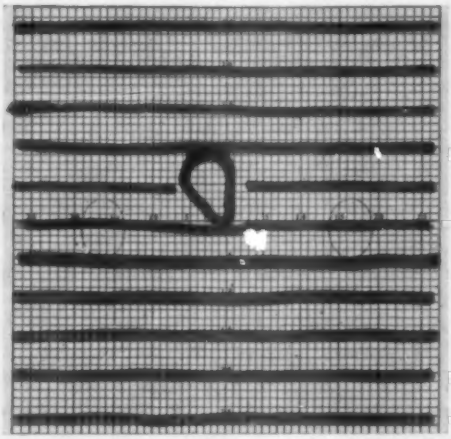


Fig. 2 (Alfano, Fabritius, and Garland). Left eye, 10/1,000 white target, vision, 20/200. *Case 1* at 10th postoperative week.

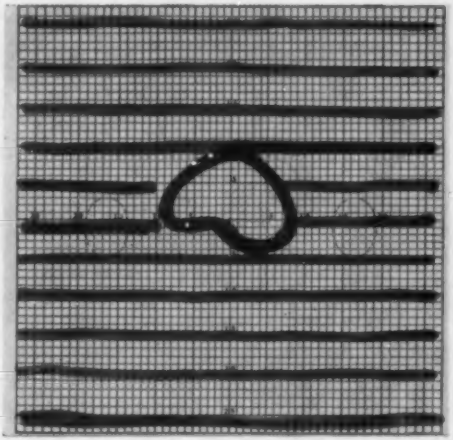


Fig. 4 (Alfano, Fabritius, and Garland). Left eye, 10/1,000 white target, vision, 20/20 —. *Case 1* at 10th postoperative month.

gery was advised. Preoperatively, the physical examination was noncontributory except for severe cardiac enlargement and a loud presystolic murmur. Blood pressure was 150/80 mm. Hg. Preoperatively there were no visual complaints and the eyes and fundi were reported normal.

A mitral commissurotomy was performed in the usual fashion and the patient was known to have a stormy postoperative course, in which he developed a right hemiplegia and facial paralysis. He was disoriented, atoxic, and had difficulty with memory. He could not see to his right side. During eight weeks in the hospital, his hemiplegia gradually improved as did his memory, but his visual difficulty persisted.

He was seen in the cardiac clinic six weeks postoperatively and the visual defect was still present. This defect continued unchanged until the seventh postoperative month, at which time the patient finally kept his appointment for the eye clinic.

Eye examination at this time revealed that although the patient still had some trouble with memory, he was fully aware of a defect in the visual field to his right side. Best corrected visual acuity measured 20/30 in each eye. Lids and fissures were normal, as were the conjunctiva and cornea. Pupils were equal and regular and measured 3.5 mm. in each eye.

Reactions to light and accommodation were normal and a hemianopic pupillary response could not be elicited. The extraocular muscle balance was normal and the intraocular pressure measured 24 mm. Hg (Schiøtz) in each eye. Examination of

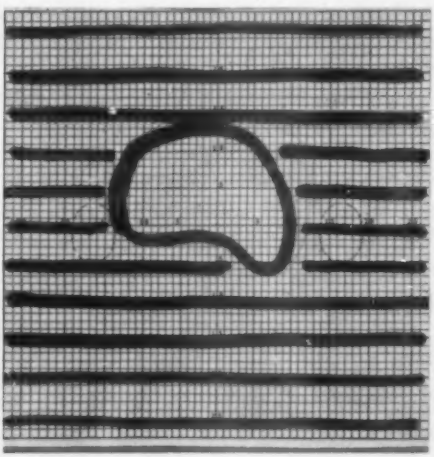
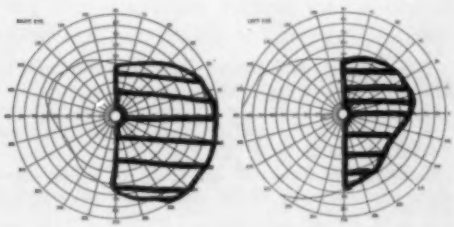


Fig. 3 (Alfano, Fabritius, and Garland). Right eye, 10/1,000 white target, vision, 20/20 —. *Case 1* at 10th postoperative month.



Figs. 5 and 6 (Alfano, Fabritius, and Garland). *Case 2*, showing a right homonymous hemianopic defect in the visual field with macular sparring. Target, 3/300 white.

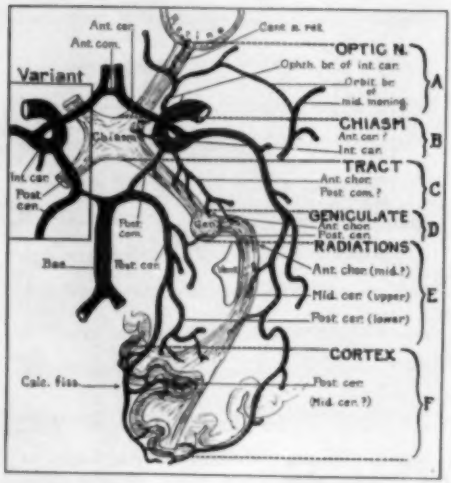


Fig. 7 (Alfano, Fabritius, and Garland). Blood supply to the visual pathways. (After Walsh and Smith: J. Neurosurg., 9:517, 1952.)

the fundi revealed slight temporal pallor of the discs, but otherwise normal fundi. No attenuation of the retinal arterioles was present. Visual fields showed a right hemianopic defect as shown in Figures 5 and 6. There was bilateral sparring of the macular areas.

Site of the lesion

In Case 1, it would appear that bilateral emboli had lodged at the junction of the middle cerebral with the posterior communicating and posterior cerebral[4] (fig. 7). In Case 2, an embolus had lodged probably in the same location on the left side.

Prognosis

Since the condition fails to respond to the usual therapeutic measures such as repeated stellate ganglion blocks and vasodilators, the defect in the field appears to be permanent (case 2), although vision may return to 20/20 as in Case 1.

Therapy

As soon as the condition is recognized, oral and intravenous vasodilators, in particular papaverine, may be given and repeated stellate ganglion blocks performed. As previously stated these are usually of no avail. The carotid arteries should be palpated in the neck.

If no carotid pulsation is felt in the neck, it may be assumed that the embolus has lodged in the cervical portion of the carotid artery. In this case the carotid artery should be explored and if an embolus is found it may be removed. Anticoagulant therapy may be instituted.

Summary

Two cases are reported in which visual loss followed the operation of mitral commissurotomy for mitral stenosis. In each case the visual loss was thought to be due to the lodgement of a saddle embolus at the bifurcation of the middle cerebral and the posterior communicating and posterior cerebral arteries. As a result of this, the blood supply to the visual radiations was impaired.

In Case 1, the bilateral involvement of the visual pathway produced blindness (light perception only) probably by the development of a bilateral hemianopic defect.

In Case 2, the embolus had lodged on the left side, with subsequent involvement of the left visual radiations, giving rise to a right hemianopic defect in the visual fields.

The usual therapeutic measures consisting of vasodilators and repeated stellate ganglion blocks appear to be ineffective.

The prognosis for the return of the visual field should be guarded, although visual acuity may return to normal.

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INTERSTITIAL KERATITIS*

Its treatment by mydriatics and hydrocortisone and its recurrence

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Interstitial keratitis associated with congenital syphilis has been for some hundred years a disease refractory to every kind of therapy. Even if it was closely linked with congenital syphilis, antisyphilitic treatment, first by metallic chemotherapy and later by antibiotics, failed to produce any appreciable improvement in the results of treatment, above all in the vision. It was only the introduction of cortisone and ACTH which opened up a new era in the treatment of interstitial keratitis. Now for the first time we have at our disposal drugs which can essentially affect the course of the disease. Local cortisone and hydrocortisone became the form of hormonal treatment most commonly adopted.

In several investigations, particularly in the beginning, optimistic views were expressed in regard to hormonal therapy, because the acuity of vision which could be established was a considerable improvement over earlier results. However, the observation time of these investigations proved to be too short. Actually, it soon became evident that the last word on the treatment of interstitial keratitis had not yet been said.

Several investigators, for example, Woods[13,14] Ashworth,[1] Klauder and Meyer,[7] Oksala,[10,11] as well as Segal and Zylo-Filipowicz,[12] cautioned against exaggerated optimism, having noted that the control of the disease often required an even longer duration of treatment than before and that the disease was more apt to recur particularly after hormonal therapy. Although recurrences caused difficulties, Oksala,[11] North,[8] and Horne[5] published end results in which the acuity of vision obtained was considerably higher than before. But the time of observation in these studies was in fact only one to three years.

Thus, new modes of therapy also produced new problems. Questions arose on how long local cortisone treatment could be carried out without injury to the eye, whether final improvement could be achieved at least in the majority of cases, whether it was at all worth while to apply cortisone therapy. No final answers could be given. One group of workers has been able to obtain continued good results with cortisone. Another, hesitating and selecting cases, has gone on with cortisone medication in the absence of a more suitable drug. A third group, for example, Klauder and Meyer, has completely discontinued the cortisone therapy and reverted to old forms of treatment.

In several cases protraction of the treatment into months is also associated with other than medical problems. In interstitial keratitis both eyes are often involved simultaneously, or one quickly follows the other. The time of onset being frequently between the age of five and 20 years, the patients are either school children, or employed in some profession. Thus the treatment of the disease is also associated with numerous social and psychologic problems. Although the disease has now become rare in several countries, nevertheless the lengthy treatment and numerous relapses have caused more difficulties to ophthalmologists than would be expected.

In our ophthalmic department we have attempted to increase the working ability of the patient and simultaneously to reduce the social and psychologic difficulties of the treatment by discontinuing mydriatics as soon as possible and then applying only local cortisone or hydrocortisone medication.

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Some cases of interstitial keratitis were treated only locally by hydrocortisone from the start. I have found in the literature only occasional mention of treatment of the disease solely by cortisone and hydrocortisone, without any detailed reports. For example, North says in his paper that he discontinued mydriatics as soon as the congestion of the eyes disappeared.

Below are presented some examples of cases which elucidate the difficulties associated with treatment and recurrence of interstitial keratitis.

Case reports

Case 1

An eight-year-old girl previously was in perfect health. Two weeks prior to admission the right eye began to grow red. In the hospital the general condition of the patient was found to be good. Sedimentation rate was 12.0 mm. The blood count was normal; albumin negative; Nylander's test, negative. Clinical examination by a pediatrician failed to reveal any pathologic features. Wassermann, one plus; cholesterol Wassermann, one plus; Kahn, three plus; and Sitolipin, one plus. Apart from keratitis, no other marks of congenital syphilis were found. The mother of the patient and a one-year-old sister were one-plus Wassermann and one-plus Kahn.

On admission, ophthalmologic examination was carried out on November 28, 1955. Vision was: O.D., 1/∞; right projection. The right cornea was edematous and revealed extensive infiltrates and precipitates. In two places on the corneal margin there was a pannus formation. Vision was: O.S., 1.0; emmetropic. The left eye was otherwise free from symptoms, but the eyegrounds exhibited "pepper and salt" changes.

Local eye treatment was instituted. One-percent atropine drops were given three times daily and 2.5-percent hydrocortisone drops every hour, day and night. After the lapse of two weeks, the right cornea had become considerably more transparent and vision was 0.6. The patient was discharged after a hospitalization of one month. At that time, the vision of the right eye was 1.0. Two small precipitates were visible in the middle of the cornea, otherwise the eye was asymptomatic. By way of antisyphilitic treatment, the patient was given 12 million penicillin units.

Local atropine and hydrocortisone treatment was continued for approximately three weeks after the symptoms in the right eye had disappeared. The treatment was terminated at the end of January, 1956. However, the patient relapsed as early as February 15, 1956, and was readmitted for treatment.

This time she stayed in the ophthalmic ward for about five weeks, and during this period the interstitial keratitis subsided completely. This time also deep vessels failed to form in the cornea. The patient continued at home with mydriatic and hydrocortisone treatment for another month. But approximately two weeks after the termination of treatment the disease recurred again.

A stronger ciliary congestion than before was manifested in the right eye. Abundant edema was seen in the cornea, with extensive infiltrates and precipitates and pannus on the corneal margin. Now the treatment of the interstitial keratitis was continued solely by local therapy with hydrocortisone but no mydriatics.

The disease yielded to this treatment as rapidly as before. Iritic hyperemia quickly disappeared. There was no formation of posterior synechias.

The treatment was gradually discontinued by November 1, 1956, and the eye has been asymptomatic for about two months since then. Acuity of vision of the right eye was at that time 1.0. Some slight scars were visible above and below on the corneal margin in the vicinity of Descemet's membrane. Abundant trabecular synechias were present in the chamber angle.

Comment

This interstitial keratitis quickly reacted to local treatment by mydriatics and hydrocortisone. However, the disease recurred with ease twice, although local treatment was gradually reduced and the asymptomatic eye was given continual treatment for another three to four weeks. The second recurrence responded quickly to hydrocortisone treatment alone. It should be noted that, although mydriatics were not used now, hyperemia of the iris disappeared rapidly. There was no formation of posterior synechias. All in all, the treatment had a duration of over one year. The patient was able to attend school while treatment by hydrocortisone alone was in progress.

Case 2

A 10-year-old girl had an onset of the disease in both eyes four days prior to admission. Previously the patient had always been healthy. The parents and one sister had had no serious diseases. At the hospital the patient's general condition was found to be good. Sedimentation rate was 20; albumin, negative; Nylander's test. negative. The blood count was normal. Wassermann, one plus; cholesterol Wassermann, one plus; Kahn, one plus; and Sitolipin, one plus. Apart from keratitis, no symptoms of congenital syphilis were present. Syphilis was diagnosed in the parents and sister of the patient.

On admission on February 16, 1956, the status of the eyes was as follows:

Vision was: O.D., 0.8; O.S., 0.8. Slight ciliary congestion was seen in both eyes. The corneas were slightly edemic and two infiltrates were seen in them. There was slight opacity of the aqueous and slight hyperemia could be distinguished in the

iris. "Pepper and salt" changes were seen in both eyegrounds.

The eyes were treated locally at first by one-percent atropine and 2.5-percent hydrocortisone drops. The latter were initially administered every hour but the dose was gradually reduced. For antisyphilitic treatment the patient was given 10 million units of penicillin.

At the end of three weeks the keratitis was completely asymptomatic. However, when two weeks had elapsed after termination of treatment, there was a recurrence of the disease, in a more severe form.

At examination of the eyes on April 4, 1956, vision was O.D., 0.3; O.S., 0.4. Strong ciliary congestion was present in both eyes. The corneas were edemic, with abundant infiltrates and precipitates, while pannus was present in several places at the margin. Nevertheless, after local atropine and hydrocortisone therapy the eye symptoms receded in five weeks. After that, local therapy was continued for about two months and a half.

The second relapse occurred four weeks after the termination of treatment. Now the disease was treated solely by local hydrocortisone, and it improved under this treatment just as rapidly as under combined atropine and hydrocortisone therapy.

Although the patient's eyes have now been free from symptoms for one month, local hydrocortisone treatment is still being administered. Two small scars remain on both corneas but no deep vessels. There was no formation of posterior synechias. Trabecular synechias were seen in the chamber angles.

Comment

Interstitial keratitis quickly receded on local atropine and hydrocortisone treatment. Recurrences came twice in the course of one year, although attempts were made to prolong the treatment and to discontinue it gradually. The disease improved just as quickly with local hydrocortisone alone as with a combined atropine and hydrocortisone therapy. Formations of posterior synechias in the iris did not occur. Because of the short observation time nothing can be said about the later recurrence. It is important that, during treatment by hydrocortisone alone, the patient was able to resume her attendance at school which had already suffered prolonged interruption.

Case 3

A 29-year-old workman in whom keratitis of the right eye due to congenital syphilis had already been diagnosed 10 years earlier was admitted. At that time, the patient was given in addition to local mydriatic therapy, four combined antisyphilitic cures (As+Bi). There was an onset of symptoms in the left eye three weeks prior to admission.

The general condition of the patient was found to be good. Sedimentation rate was 8.0 mm. in one hour. The blood count was normal; albumin, negative; Nylander's test, negative. Radiologic examination of the thorax revealed no pathologic features. Except keratitis, no other symptoms of congenital syphilis were found. Wassermann, negative; cholesterol Wassermann, negative; Kahn, negative; Sitolipin, one plus.

On admission, October 10, 1956, examination of the eyes revealed vision to be: O.D., with a −1.0D. cyl. ax. 10°, 0.20; O.S., 0.4. The right cornea showed deep scars and some deep vessels. Trabecular synechias were abundantly present in the chamber angle. The right eyeground was normal. The left eye had strong ciliary injection (+2). The left cornea was edemic, showing deep infiltrates and precipitates. There was slight opacity of the aqueous (+1). The iris was also slightly hyperemic (+1).

The patient's left eye was treated from the beginning solely by local hydrocortisone. It was initially introduced as a 2.5-percent suspension every hour, with a later gradual increase between the times of application. The eye improved as expected and was free from symptoms after three weeks of treatment. Only a small central scar remained on the cornea; it did not appreciably affect the vision. Neovascularization did not occur. There was no formation of posterior synechia in the iris. The eye fundus had a normal appearance. Gonioscopic exploration of the chamber angle failed to reveal goniosynechias. The patient is still under local hydrocortisone therapy but, nevertheless, he is fully able to work.

Comment

The patient's right eye had been affected with interstitial keratitis before the cortisone era; the disease greatly impaired his vision which, with the aid of glasses, was 0.2. Interstitial keratitis in the left eye was treated solely by local hydrocortisone therapy. The disease quickly responded to this treatment in the usual manner, without leaving in its train appreciable corneal changes. No formation of posterior synechias occurred in the iris. Because of the shortness of observation time nothing can be said about the tendency to recurrence. It is of interest that, contrary to the state in the right eye, no goniosynechias were formed in the left chamber angle. The patient was fully able to work after his discharge from the hospital, while local hydrocortisone therapy was continued.

Discussion

The described cases of interstitial keratitis are only some instances of those which were treated in the course of the years. Among the 16 patients recently treated for interstitial keratitis (25 eyes) by cortisone or hydrocortisone, there were eight cases (13 eyes) which had to be treated for at least one year because of recurrences. Before the

introduction of cortisone, fewer relapses were observed. In my own previous investigations[9] their incidence was 12.5 percent. Igersheimer[6] obtained a corresponding figure of 14 percent, Granström[4] 5.5 percent, and Dalsgaard-Nielsen[3] 5.0 percent. In my experience, even prolonged cortisone treatment fails to affect the tendency to recurrence to any noteworthy degree.

According to the experimental researches of Chesney and Woods,[2] immunity of the cornea is associated with its neovascularization. Cortisone, by prohibiting vascularization, simultaneously delays permanent improvement. In some of my earlier investigations, I noticed that interstitial keratitis often leaves in its train pathologic changes, not only in the cornea but in the chamber angle and the iris as well. The chamber angle reveals pigmentation and goniosynechias; the iris also shows pigment disintegration and atrophy. If one remembers that interstitial keratitis usually begins as a deep limbal infiltration, the possibility should also be taken into account that the effect of cortisone, paralyzing the disease and preventing immunity, may also prevent its affecting the iris, ciliary body, and chamber angle.

Both in interstitial keratitis and chronic sclerokeratitis there is a similar tendency to recurrence and to corneal neovascularization. I have found that in these diseases corneal neovascularization decisively affects recurrences only when the major part of the cornea becomes neovascularized and simultaneously atrophied. The recurrence of the disease in a thin and scarred cornea may even have been aggravated by change in the anatomic and physiologic properties of the cornea, and because there was less tissue sensitive to anaphylactic reaction than before. This is also true in the iris and the ciliary body.

Atrophy of the iris and ciliary body is common after severe interstitial keratitis. Therefore, the tendency to anaphylactic reaction can be considerably reduced in these tissues as well, because of scars and atrophy. Observations I have made in the course of several years indicate that the more extensive the atrophic changes produced by the disease in the cornea, chamber angle, and iris, the less is the tendency to recurrences.

Previous experience on the poor effectiveness of treatment and new observations on the dramatic effect of cortisone on interstitial keratitis have given rise to the idea of attempting to treat the disease solely by local hydrocortisone. In the cases I treated, improvement was not delayed, although mydriatics were omitted. The disease could also be rapidly cleared up from the beginning by local hydrocortisone treatment alone. Recurrences did not appear to increase as a result of this treatment.

The circumstance, that it is possible to omit mydriatics in the treatment of interstitial keratitis without appreciable disadvantages, is due both to the sensitive reaction of the disease to cortisone and to its eminently serous nature. The tendency to formation of posterior synechias is much less in interstitial keratitis than, for instance, in fibrinous rheumatic iritis.

Treatment by hydrocortisone has the advantage over a combined mydriatic and hydrocortisone therapy in that there is less formation of goniosynechias. This I have been able to establish in my cases by gonioscopic exploration. The movements of the iris prevent the closing of the chamber angle. This danger is most pronounced in those eyes which already have an hereditary narrow chamber angle.

The omission of mydriatics increased the working ability of the patients, which, in a disease of such long duration, has an important economic and psychologic significance. It is worth mentioning in this connection that I failed to establish any clinical disadvantage of local hydrocortisone treatment to the eyes, even when it was lengthy and had a duration of several months. The corneal epithelium remained whole and transparent.

All things considered, is cortisone therapy

worth while in interstitial keratitis? No decisive answer can, as yet, be given to this question. My experience is that there are numerous cases in which the disease can be controlled by local cortisone therapy, at least for some years. Theories on later recurrences and their management can only be formed after several years' observation. On the other hand, there are cases in which cortisone therapy must be abandoned and the old methods reverted to, fever therapy for instance, on account of repeated recurrences and the originally severe character of the disease. Since acuity of vision in the eyes treated by old methods remained at 0.3 or even fell short of it in 20 percent of the eyes, I feel it would be well to make, at least initially, an attempt at local cortisone or hydrocortisone treatment.

Summary

I have given local cortisone or hydrocortisone therapy to 16 patients with interstitial keratitis associated with congenital syphilis. Eight of them had recurrences which necessitated treatment of several months' duration. According to my clinical observations, corneal neovascularization clearly reduced recurrences only if it involved the main part of the cornea. It is possible that, apart from neovascularization, atrophy and formations of scars in the iris, the ciliary body and the chamber angle also had the effect of inhibiting recurrences. This effect is based on the altered anatomic and physiologic conditions. There is less tissue sensitivity to anaphylactic reaction than before.

I have treated interstitial keratitis by local hydrocortisone only. Both in the initial and later stages, the disease responded to this therapy just as well as to a combined mydriatic and hydrocortisone treatment. No formation of synechias occurred in the iris. One should consider, as a benefit of the treatment, first, that there is less frequent occurrence of goniosynechias and, second, that the omission of mydriatics increases the patient's working ability during prolonged treatment. A theory on a later tendency to recurrences can only be formed after several years of observation.

It can be said that the treatment of interstitial keratitis associated with congenital syphilis has not yet been finally solved.

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LOCAL IRRADIATION OF METASTATIC CARCINOMA OF CHOROID WITH RADIOACTIVE IODINE*

A PRELIMINARY REPORT

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Treatment of tumors of the posterior ocular segment by means of local irradiation has been reported in recent years by Stallard,[1] who has described the effects of radon seeds, radium discs, and cobalt in eyes containing retinoblastomas. Additionally, he has described the histologic changes which follow this method of therapy. More recently Newell, Harper, and Koistenen[2] reported the effects of focal area irradiation on the posterior ocular segment in experimental animals using beta rays derived from yttrium.[90]

Harper[3,4] and his co-workers have described the radiation of abdominal tumors by means of radioactive isotopes in a series of reports. A method of placing a polyethylene envelope containing blotting paper adjacent to the tissue to be irradiated and subsequently filling the envelope with an isotope solution has been developed and its use reported by them[4] in the treatment of metastatic malignancy to the brain. This method appears to be of possible value in ophthalmology in that ocular tumors are frequently of relatively small size when first diagnosed. Additionally it is difficult to avoid injury to the lens, skin, and orbital bones when small areas are treated with high intensity methods by external irradiation. The chief advantage offered by the polyethylene envelope over the method of Stallard is the elimination of the need for subsequent removal of the implant. In addition, radiation exposure to the operator during surgery is completely eliminated.

The isotope chosen for use, I^{131}, has suitable gamma radiation, is readily available, and has proper chemical properties for concentration to the necessary small volume of solution.[4] The beta radiation from this isotope produces a very intense radiation field in the tissues in immediate contact with the applicator. The gamma radiation dosage calculated at complete decay surrounding one cm. square plane applicator is shown in Figure 1. These curves may be scaled up or down for different sized applicators as long as the isotope density per square centimeter remains constant.

The envelope technique has been used in but a single patient but the lack of reaction and the beneficial effects were so dramatic as to warrant this preliminary report.

CASE REPORT

The patient, a 53-year-old white woman, was seen in the Eye Out-Patient Section of the Albert

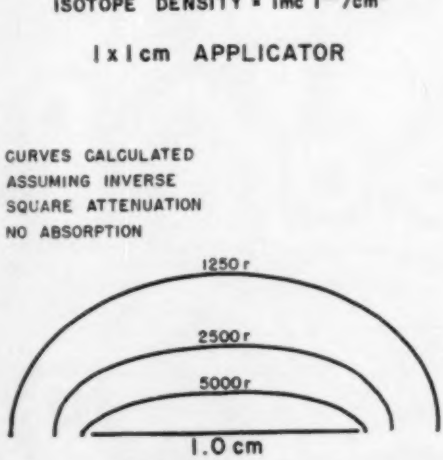


Fig. 1 (Newell and Harper). Isodose curves showing gamma ray dosage surrounding a 1.0 by 1.0 cubic plane applicator assuming complete decay, 2.25 r/mc. hr. at one cm.

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Merritt Billings Hospital on November 14, 1956, complaining of progressive loss of vision in the left eye.

Eye examination indicated vision in the left eye to be faulty light projection. The retina was completely detached and was touching the lens. Vision in the right eye was 20/20. In the inferior portion of the fundus of this eye, there was a circumscribed detachment, elevated two or three diopters, involving both the nasal and temporal quadrants. Peripheral to this area were several obviously inactive small sites of healed chorioretinitis with pigment proliferation. There were no holes and the detachment appeared smooth and relatively flat.

Physical examination. The patient had had a partial left mastectomy followed by roentgen-ray therapy in 1952 for a cyst of the left breast. Physical examination indicated the left nipple and central portion of the breast had been excised but much breast tissue was still present. The left axillary space contained hard lymph nodes; a pleural effusion was present on the left side, and the patient was obviously dyspneic.

Roentgen-ray studies indicated a massive pleural effusion on the left side which had extended over the apex of the left lung. The thoracic cage suggested extensive metastatic disease with many small destructive lesions throughout the ribs. The entire pelvis and upper portions of the femoral bones were riddled with osteoplastic and osteolytic lesions.

A diagnosis of bilateral metastatic cancer of the choroid, probably originating in the breast was made. The radioactive-phosphorus uptake in the left eye was definitely abnormal after 24 hours but no defect could be demonstrated in the right eye.

Treatment. A week after the patient was first seen, the detachment in the right eye was much more extensive. On November 23, 1956, two polyethylene envelopes containing one-cm. squares of blotting paper (fig. 2) were sutured to the inferior nasal and inferior temporal portions of the sclera over the estimated area of the tumor. A conjunctival incision was made extending from the inferior border of the lateral rectus muscle to the inferior border of the medial rectus muscle and the underlying Tenon's capsule reflected. The envelopes were then fastened to the globe by means of overlying mattress sutures which did not pass through the envelopes. Fine polyethylene tubes leading from the envelopes were brought out through a stab incision in the right temporal region. There was but a moderate reaction to the procedure.

On November 27, 1956, four days after the implantation of plastic envelopes, 1.5 mc. of iodine^{131} were injected into the tube leading to the temporal envelope in a volume of strong potassium iodide solution sufficient to saturate the enclosed blotting paper. (0.03 ml.). Isotope adhering to the tubing was rinsed in with an additional 0.005 ml. of potassium-iodide solution. The envelope in situ is shown in the roentgenogram of the skull (fig. 3).

The end of the polyethylene tube was closed by means of a flame and cut off flush with the skin and allowed to retract into the tissue. There was a transient moderate conjunctival reaction following this procedure.

Four days after the implantation of the isotope there was a retinal pigmentary reaction in the area adjacent to the envelope and the retina appeared to be much flatter than previously. This pigmentary reaction gradually increased until the entire area was diffusely speckled with choroidal pigment and the retina was flat.

On December 13, 1956, a bilateral oophorectomy and bilateral adrenalectomy were performed. This procedure was followed by considerable improvement in the general condition of the patient. When last seen four months after the procedure, the right retina was completely flat and no field defect could be demonstrated perimetrically. Vision in the right

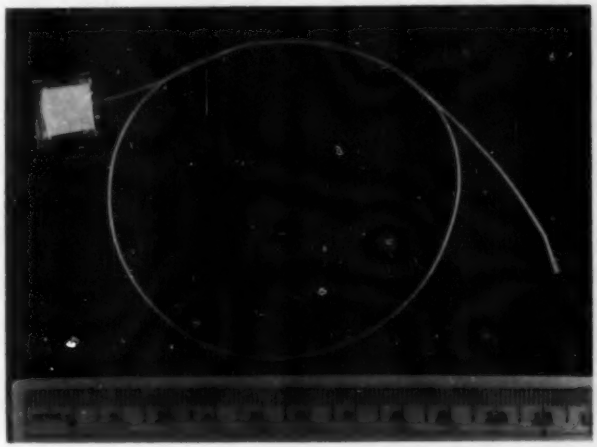


Fig. 2 (Newell and Harper). A 1.0 by 1.0 cm. polyethylene applicator. The envelope is constructed of a double thickness of 0.002 inch polyethylene sheeting. The tubing is Clay-Adams PE-10, polyethylene medical tubing.



Fig. 3 (Newell and Harper). Roentgen-ray examination of skull, showing polyethylene envelope in right orbit.

eye was 20/20+4 with a +2.0D. sph. ⊃ +0.75D. cyl. ax. 180°. The area of detachment was entirely flat and pigmented and there was no evidence of metastatic activity in the eye. The left eye was unchanged.

Discussion

Localized radiation to small lesions of the posterior segment of the eye seems entirely logical because of the difficulty of focusing conventional radiation therapy apparatus directly upon the lesion. Additional problems with conventional irradiation arise because of the possibility of cataract, the production of severe cutaneous lesions, and the necessity for administering relatively high doses of radiation. With a radioactive isotope the area of the lesion can be precisely treated with high dosages. Previous histologic studies have indicated the sclera is relatively resistant to radiation and that a necrotizing dose which would cause perforation of the globe is relatively unlikely with the dosages used here. In this patient, the calculated gamma ray dosage was 5,000 r delivered to the apex of the tumor which was estimated to be three mm. from the sclera.

The technique developed here is extremely simple. The chief technical problem encountered was the perforation of one of the polyethylene envelopes with the sharp instruments used in ophthalmic surgery. Hereafter, the sutures will be embedded in the polyethylene envelopes itself so that it may be attached to the globe without manipulation.

In the rabbits, reported by Newell, et al.,[2] which were treated by means of beta radiation which does not penetrate as deeply as gamma rays, there were no instances of cataract developing. It must be pointed out, however, that mature animals were used and the period of observation was only one year. However, it is believed that the danger of radiation cataract is relatively remote if the isotope is selected with care.

Conclusions

A method of local focal radiation to the posterior segment of the globe is reported and a preliminary report presented of its use in one case.

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THE APPEARANCE TIME OF FLUORESCEIN AS AN INDEX OF AQUEOUS FLOW*

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Fluorescein as an easily visible test substance has been widely used in ophthalmologic research after Ehrlich's discovery of the passage of fluorescein into the anterior chamber in 1882. The dye appears in the anterior chamber as a vertical line behind the cornea, the so-called Ehrlich line. In model experiments Türk (1906)[13] showed that this distribution of fluorescein could be explained by the difference in temperature between the surface of the iris and the cornea.

The site of entrance of fluorescein was a matter of discussion over a long period of time. On the one hand the dye was considered to enter the anterior chamber entirely through the anterior surface of the iris.

Support of this theory was furnished among others by Hamburger (1914).[9] After injection of fluorescein he could not detect any trace of the dye in the posterior chamber.

On the other hand fluorescein was supposed also to enter the posterior chamber and follow the aqueous flow through the pupil into the anterior chamber. Seidel (1918)[12] punctured the posterior chamber of the eye of cats and rabbits 30 to 150 minutes following injection of fluorescein and found fluorescein of approximately the same concentration as that found in the aqueous humor of the anterior chamber from the same eye.

After injection of fluorescein into the vitreous body, Weekers (1921)[14] was able to demonstrate the appearance of the Ehrlich line in the anterior chamber. In this experiment the dye must have entered the anterior chamber through the pupil.

Kajigaja (1951)[10] performed iridectomy in rabbits and studied the ciliary body by a gonioscope. Intravenously injected dyes appeared only in the ciliary body in normal eyes, but both in the ciliary body and the iris if the eye was inflamed.

More recently Amsler and co-workers followed the change in concentration in the anterior chamber of human beings over a period of about 30 minutes in order to study the blood aqueous barrier (for review see Amsler, et al., 1955).[1] The rate of disappearance of fluorescein from the anterior chamber in human beings as compared to the plasma level was utilized by Goldmann for calculating the rate of flow of aqueous humor (for review see Goldmann, 1955).[8]

There are some reports in the literature of the time elapsing between the injection of fluorescein and the appearance of the dye in the anterior chamber. This time interval was, however, not applied as a method of measuring the rate of flow of aqueous humor. The purpose of the present study, which was suggested by the late Dr. Friedenwald, was to determine whether the time interval elapsing between the moment the fluorescein reached the eye and the moment it appeared in the pupillary area could be correlated with the rate of the aqueous flow;

* From the Wilmer Ophthalmological Institute of The Johns Hopkins University and Hospital. This work was supported in part by the Kellogg Foundation, the Swedish Medical Research Council, and the National Institute of Neurological Diseases and Blindness of the National Institutes of Health. Presented in part at the clinical meeting of the Wilmer Residents Association, April 2, 1954, and at the 24th meeting of the Association for Research in Ophthalmology, June 8, 1955.[7] This project was initiated by Dr. Jonas S. Friedenwald, whose untimely death did not allow his participation in the writing of this report.

and if this so-called appearance time could be utilized as an index of aqueous flow.

Materials and Methods

Male pigmented rabbits weighing between 1.5 and 2.5 kg. were used.* They were fed a Sherwood-Feed pellet diet and water ad lib. The animals were placed in a wooden box with the head outside the box or fixed on a wooden board by means of a towel. No anesthesia was necessary. A five-percent solution of sodium fluorescein (C. F. Kirk & Company, New York) was used. The dye was injected in one of the ear veins and the injection was completed within 10 seconds.

The experiments were performed in a dark room with the rabbit placed in front of a slitlamp. A Bausch & Lomb slitlamp with a white, not especially strong light was used in most experiments, but in some of the later ones a Haag-Streit slitlamp with white light was utilized. Great care was taken to keep the rabbit quiet and avoid any stress or excitement. The time which elapsed from the moment fluorescein was injected intravenously into an ear vein and its appearance in the vessels of the conjunctiva and nictitating membrane was recorded; this time interval lasted an average of 10 seconds. The pupil was observed through the slitlamp and the time of the appearance of fluorescein in the pupillary area was registered. The time interval between the arrival of the dye in the conjunctival vessels and in the pupil was taken as the appearance time.† Fluorescein usually appeared in a limited area often at the lower part of the pupil. Usually not more than 10 to 15 seconds elapsed from the time the first faint trace appeared to the moment a clearly visible cloud of the dye could be seen.

In most rabbits a small amount of fluorescein could be observed entering the anterior chamber through the anterior surface of the iris. The end-point—fluorescein appearing in the pupil—could be determined only if the amount of fluorescein coming through the anterior surface of the iris was small as compared to the cloud of dye appearing in the pupillary area. That was found to be the case in most of the experiments. In some of them, however, especially with a long appearance time the aqueous humor was filled by fluorescein entering through the anterior surface of the iris, thus preventing the observation of the appearance of the cloud in the pupillary area. These experiments had to be excluded. The interpretation of the intraocular pressure was based on the 1954 tables of Friedenwald.[6]

The puncture of the posterior chamber was performed under topical anesthesia using 0.5-percent Ophthaine after proptosing the eye. The fluid withdrawn from the posterior chamber was examined in a dark room by means of the slitlamp.

In some experiments the kidneys were removed under general anesthesia (pentobarbital sodium 65 mg./ml.; 0.5 ml./kg. body weight) one day preceding the determination of the appearance time.

Results

According to Seidel, fluorescein was found in the aqueous of the posterior chamber of rabbits 30 to 150 minutes after the injection. In order to determine if fluorescein was present in the posterior chamber shortly after an intravenous injection of fluorescein the following experiments were performed in five rabbits. One eye was proptosed and the posterior chamber was punctured at time intervals varying between 20 and 120 seconds after the injection of the solution. The tap could be finished within 30 to 40 seconds after proptosing the eye. Fluorescein was clearly visible in all of the aqueous samples, showing that it is possible for fluorescein to enter the posterior chamber.

In one group of rabbits the measurements of the appearance time were repeated with different amounts of fluorescein varying between 25 and 250 mg. At least one week was

* Purchased from Research Supply Company, Philadelphia.

† In the preliminary reports the time from the beginning of the injection to the appearance in the pupil was recorded as the appearance time.

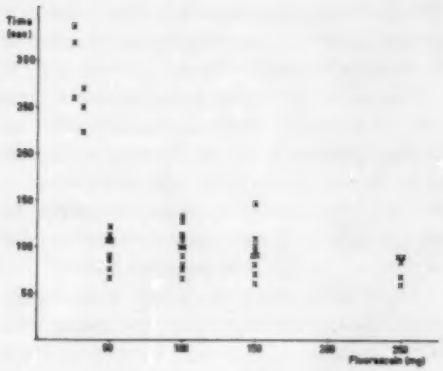


Fig. 1 (Linnér and Friedenwald). The effect of varying amounts of fluorescein on the appearance time.

allowed to elapse between subsequent experiments in the same animal. Figure 1 demonstrates no significant difference in the appearance time when between 50 and 250 mg. fluorescein were used, showing that the amount of fluorescein was not a critical factor. When 25 or 37 mg. of fluorescein was used, the dye appearing in the pupillary area was extremely faint and the appearance time was prolonged. The amount of fluorescein used in the following experiments was 100 to 150 mg.

The average appearance time, repeated twice with an interval of one week in a group of 12 normal rabbits, was found to be 95 seconds the first time and 102 the second time. The ratio between the first and the second determination was 0.94 ± 0.048. The results of two additional rabbits in this group were excluded, because the ratios (2.60 and 2.33) were falling outside seven times the standard deviation ($s = 0.17$).

The effect of the carbonic anhydrase inhibitor, acetazolamide, on the appearance time and on the intraocular pressure was measured. The average appearance time in a group of 10 normal rabbits was 123 seconds. After an interval of at least one week, the rabbits were nephrectomized and the following day given an isotonic solution of acetazolamide intravenously: eight of them received 250 mg. and two of them 100 mg. About four hours later the appearance time was measured. The average value was 228 seconds as compared to 123 without acetazolamide with a ratio, 1.89 ± 0.14, which is significantly different from unity. The intraocular pressure dropped from 22 to 13 mm. Hg with a ratio between the values with and without acetazolamide of 0.57 ± 0.079 which is significantly different from unity.

The influence of nephrectomy on the appearance time was studied. One week following determination of the appearance time in a group of 10 normal rabbits the kidneys were removed and the appearance time was measured the following day. Before the operation the appearance time was 107 seconds and after 98, with a ratio of 0.95 ± 0.10. No significant difference between the determinations was found.

The effect of para-amino-hippuric acid (PAHA) Eastman-Kodak, Rochester, New York, on the appearance time was examined. An intravenous injection of 0.5 gm. sodium para-amino-hippurate dissolved in 15 ml. bicarbonate was found significantly to prolong the appearance time in 11 nephrectomized rabbits as compared to the time found in the same group of rabbits one week preceding the PAHA experiment. The time without PAHA was 94 and with PAHA 144 seconds. The ratio was 1.56 ± 0.10. The intraocular pressure, measured before and after the injection of PAHA, did not reveal any significant change. In order to investigate if a large volume of fluid might cause a change of the appearance time, a solution of 15 ml. physiologic sodium chloride was used. The appearance time in nine rabbits before was 99 and after the injection 108 seconds with a ratio of 0.94 ± 0.12, showing no significant change.

Discussion

The method of the appearance time was found to show a considerable variation from rabbit to rabbit as well as with repeated determinations in the same animal. The ciliary processes in rabbits are located on

the posterior surface of the iris and reach a point not far away from the pupillary margin. By puncture of the posterior chamber it was shown that fluorescein can enter the posterior chamber. The entrance might, however, take place in different parts of the ciliary processes at varying distances from the pupillary margin. This anatomic situation might be a factor of importance for the variation of the appearance time. The amount of fluorescein, varying between 50 and 250 mg., did not show any influence on the appearance time, while a prolongation of the appearance time was found, using a smaller amount of 25 or 37 mg. of the dye. These results support the assumption that fluorescein enters the pupillary area predominantly by a mechanism of bulk flow from the posterior chamber.

In order to investigate if the appearance time could be utilized as an index of aqueous flow, the rate of the aqueous flow was experimentally changed by means of the carbonic anhydrase inhibitor acetazolamide.

Acetazolamide was found to increase the appearance time significantly. A similar experiment was performed some months later together with E. Prijot and H. Stone. The appearance time was determined in eight rabbits under general anesthesia using orally administered paraldehyde U.S.P., 1.5 ml. per kg. body weight, mixed one to seven with tap water. The appearance time was 61 seconds. A week later the rabbits were nephrectomized. The day following the operation 250 mg. acetazolamide were injected intravenously and the appearance time was measured. The result was found to be 83 seconds. The ratio between the appearance time with and without acetazolamide was 1.97 ± 0.49.

Becker[3,4] using the same method of measuring the appearance time in rabbits found a prolongation of the appearance time. In patients he found a similar prolongation of the appearance time. Langham[11] using a method of objective fluorophotometry measured the time for fluorescein to appear immediately in front of the lens in rabbits. The time was significantly longer after administration of acetazolamide as compared to the result without the drug.

The prolongation of the appearance time following administration of acetazolamide in the above-mentioned experiments seems to be in good agreement with a decrease in the rate of aqueous flow and supports the assumption that the appearance time can be used as an index of aqueous flow.

There are, however, other experiments which do not correspond to the above-mentioned results.

Using three different fluorescent substances Berggren[5] studied the relation between log-dose of the dyes and log-time of appearance and found a deviation from a straight line at approximately five minutes for all the three substances, indicating that the rate of aqueous flow influences the appearance time if a high dose was used. On the other hand factors influencing the convection in the anterior chamber, as the outside temperature and the position of the eyeball were shown to be able to change the appearance time. Furthermore, following administration of acetazolamide, no prolongation of the appearance time was found in contrast to the other previously mentioned experiments. These findings indicate that fluorescein visible in the pupil can be the result of convection currents in the anterior chamber. It is not clearly understood if different strains of rabbits or if some other factors play a role in whether the fluorescein in the pupil mainly comes from the posterior or from the anterior chamber.

An uncertainty seems therefore to be involved in the method, because of the fact that it is not possible clearly to differentiate between the fluorescein coming from the anterior chamber and that coming from the posterior chamber. If measurements of the rate of aqueous flow are obtained by the method of appearance time, the results ought to be confirmed by other methods with different inherent errors.

Bárány and Wirth[2] used an intravenous

infusion of para-amino-hippuric acid (PAHA) in experiments for determination of the rate of aqueous flow. After paracentesis of one eye they found in some animals an almost complete cessation of the rate of aqueous flow. They suggested that this effect might be a consensual reaction to the paracentesis of the first eye, but also that the test substance in itself might reduce or stop the rate of aqueous flow.

Following administration of PAHA in nephrectomized rabbits the appearance time was found to be significantly prolonged. On the other hand no significant change of the intraocular pressure was found.

The increase of the appearance time would suggest a decrease in the rate of aqueous flow, but a drop of the intraocular pressure similar to that found after administration of acetazolamide would be expected. No change of the intraocular pressure was, however, found. A constant intraocular pressure during changing aqueous flow would be possible only by means of an absolute compensatory mechanism. The problem has not been clarified and merits further investigation.

Summary

In rabbits fluorescein was injected intravenously and the time interval elapsing between the dye reaching the eye and appearing in the pupillary area was determined. The experimental results indicate that this so-called appearance time could be correlated with the rate of flow of aqueous humor and, at least under certain circumstances, could be utilized as an index of aqueous flow. There is, however, an uncertainty involved in the method because direct observation of the cloud of fluorescein appearing in the pupil does not allow a differentiation between fluorescein coming from the anterior chamber and from the posterior chamber.

The Johns Hopkins Hospital (5).

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EVALUATION OF RESEARCH ON EFFECTS OF VISUAL TRAINING ON VISUAL FUNCTIONS*

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This report presents an evaluation of research on visual training with reference to a number of visual functions. Over a considerable period proposals for improvement of various visual abilities and conditions through some form of training have appeared in the literature and attracted attention. Nevertheless the present status of this general approach is rather uncertain. It is the purpose of this report to review and evaluate the literature on visual training in an effort to provide an objective basis for appraisal of various techniques.

In evaluating a therapeutic procedure it is necessary to specify the initial condition to be corrected, the method employed, and the criteria for estimating results. Some of the advocates of visual training procedures have proceeded in this conservative, scientific manner. Unfortunately, however, many claims for visual training have been extravagant, including the successful treatment of a wide range of conditions, from eye strain, myopia, hyperopia, presbyopia, and astigmatism to strabismus and even cataract and glaucoma.[3–5, 19, 20, 25, 41, 53, 57] These latter have been received with forthright criticism and condemnation.[13, 14, 15, 39, 40, 52] As a result, the criticism has become generalized and the field has acquired a controversial aspect. Objective consideration of reasonable possibilities of specific training procedures has consequently been retarded, despite an abundance of data.[1, 10, 28, 29, 31, 33, 45, 48, 50, 51, 54–56, 60, 61, 66]

Vision involves a series of complex processes which Marx[47] has grouped, for simplicity of discussion, into four phases: optic, receptive or retinal, conductive, and perceptive. Although visual responses at each phase can be isolated, the components of these four phases form an integrated process in the visual act.

Much of the effort of ophthalmologists has been concerned with studies of anatomy, physiology, and pathology related to the optic, receptive, and conductive phases. Perceptual problems have, to a greater degree, been investigated by psychologists. The present report is the result of collaboration by an ophthalmologist and a psychologist to dissolve the traditional disciplinary boundaries and study an important problem of vision in terms of the total integrated process.

Visual training procedures depend on the general hypothesis that through appropriate conditions of learning particular visual functions can be improved. The rationale for such procedures must be either orthoptic or perceptual. Orthoptic training involves learning of binocular functions through training of particular muscles or muscle groups by means of exercises using some variation of the basic amblyoscope. Perceptual training involves practice in making perceptual judgments under conditions conducive to learning. In some situations, both considerations may apply.

Where a disease condition exists, the rationale of a therapy involving training may be considered in relation to etiology and the nature of the disease process. This problem is beyond the scope of the present paper, although it may be noted that no authenticated claims for the treatment of pathologic conditions, such as cataract or glaucoma, by means of eye exercises, have been published, to our knowledge.

The general problem of motor anomalies is also excluded because of the manifold difficulties and lack of adequate evaluative research. Although many cases have been observed in which orthoptic training has con-

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tributed to the re-establishment of binocular function in cases of diplopia, suppression, impairment of fusion related to muscle imbalance, or to reduction of apparent myopia resulting from accommodative esophoria, no definitive controlled studies have yet appeared. Experienced workers in this field recognize the many concomitant anatomic, physiologic, motor, and psychologic factors involved, which present major difficulties of systematic classification of cases and control of conditions.

This review is primarily concerned with visual training other than that directed at treatment of pathologic eye conditions or motor anomalies. Since the variety of training methods is extensive, the discussion is organized in terms of the particular visual functions which have been investigated and the training techniques will be described as required.

Visual efficiency

There is acceptable evidence that in motivated subjects, even myopes with greater than two diopters refractive error, visual acuity as measured with standard charts can be improved by visual training. Such improvement does not occur with or by reduction of refractive error. The results must therefore be considered perceptual.

Woods' widely known Wilmer Institute Study in 1945[66] evaluated the effects of the optometric training technique devised by Skeffington on visual acuity and refractive error in 103 uncomplicated myopic subjects. Thirty subjects showed an average improvement in visual acuity of 27 percent while the same number dropped an average of 11 percent. Woods concluded that the improvements obtained were based on learning to interpret blurred images rather than on any changes in refractive error.

In a similar study of 54 myopic subjects with refractive errors of one to three diopters, at Washington University, in 1947, Hildreth, Meinberg, Milder, Post, and Sanders[31] found definite improvement in 22 percent of the subjects.

Sloane, Dunphy, and Emmons, in 1948,[61] obtained negative results in training eight teen-age boys with a three-dimensional tachistoscope.

Finally, a recent and as yet unpublished study by Berens, Girard, Fonda, and Sells,[7] supported by the Snyder Ophthalmological Foundation and the American Committee on Optics and Visual Physiology, using the Renshaw tachistoscopic training technique,[50] found an increase in visual acuity in 74 of 80 highly motivated trained myopic subjects, with a net mean increase of 30 percent after subtracting the slight mean decrease of the control group from the original experimental group mean gain. Significantly, no net change in retinoscopic refractive error (with cycloplegia) was found, although variations of 0.25D. in group means occurred.

The variations among the results of these four studies can probably be accounted for by differences in training program, motivation of subjects, initial visual performances, and numerous other factors. However, they do provide evidence of improvement in visual acuity not explained by refractive changes. Woods, Lancaster, Post, and others recognized this as perceptual learning, but perhaps their use of the term "learning to interpret a blur" was interpreted by some as deprecation of the significance of such learning.

Lancaster recognized this as most important and exhorted ophthalmologists to explore this problem as shown in the following quotation from him in 1944:[39]

"There is abundant evidence for the general proposition that exercises, repetition, practice, and learning lead to better performance, to the acquisition of skill. Many ocular conditions exemplify this law. Since seeing is only partly a matter of the image on the retina and the sensation it produces, but is in still larger part a matter of the cerebral processes of synthesis, in which memories play a principal role, it follows that by repetition, by practice, by exercises one builds up a substratum of memories use-

ful for the interpretation of sensations and facilitates the syntheses which are the major part of seeing. . . . Ophthalmologists have neglected this field and have concentrated their attention on the primary source of the sensation, the image on the retina. . . . The achievements . . . should stimulate ophthalmologists to investigate and discover the valuable possibilities in this field. . . ."

In the study of Berens, Girard, Fonda, and Sells, the correlation between measures of visual acuity and refractive error ranged from 0.58 to 0.70, indicating that not over 50 percent of the variance in visual acuity was accounted for by structural, optic, and anatomic factors reflected in the retinoscopic refraction. Perceptual skills, involving form discrimination, associating fragmentary cues to stimuli, speed of perception, brightness discrimination, and many others, account for the major portion of the remaining variance.

Perceptual judgments

Renshaw, in 1945,[54] demonstrated that tachistoscopic training with digit patterns produces marked increase in reading speed and comprehension, measured by standard tests, and enlarges form fields in the vertical and horizontal meridians. These findings with respect to reading speed and comprehension have been confirmed by Olson[51] and Melcer and Brown.[48] Berens, Girard, Fonda, and Sells obtained similar results with respect to reading speed and also for form field. They found a net increase of 20 percent in form field, attributable to tachistoscopic training.

In a recent comprehensive review of literature on improvement of perceptual judgments as a function of controlled practice, Gibson[25] enumerated many other areas of visual perception in which positive effects of training have been found under controlled experimental conditions. These include foveal and peripheral visual acuity, upper and lower thresholds of visual sensitivity, spatial judgments of nearer or farther, of two dimensional length or visual extent, correction for a number of visual illusions, estimation of areal size, angle, depth, distance, speed, and form. Learning effects have also been obtained for the recognition of patterned stimuli under what Gibson has termed "impoverished conditions of stimulation," including peripheral presentation of stimuli, low illumination (night vision), and brief (tachistoscopic) presentation of stimuli.

During World War II much effort was made to train color-deficient persons to discriminate hues. Although some claims of success were made[19, 20, 41] evaluation of the improvement in these cases[9, 27] suggested that it could be accounted for in terms of increased knowledge of the tests, usually pseudo-isochromatic plates, which consisted of identifying cues based on brightness differences in the plates. The study by Gallagher, Ludvigh, Martin, and Gallagher, in 1947,[27] found that training with pseudo-isochromatic plates did not improve performance on a desaturation test or vice versa. Chapanis[9] followed up three "improved" cases after four years and found that they could give correct responses on pseudo-isochromatic plates only where they had learned specific cues.

Evaluation of the extensive literature represented by this brief review leads to the conclusion that perceptual responses including the size of the visual form field, visual thresholds, visual acuity, and a wide range of perceptual judgments under varying stimulus conditions have been and can be improved by appropriate training methods. On the other hand, the refractive errors, determined objectively by retinoscopy and hue discrimination, which are largely limited by anatomic, structural characteristics of the organism, have not responded to training techniques. It may be concluded that present evidence points up the educability of perception as a fertile area for development of improved visual performance.

Perception is the process whereby an individual experiences an external situation as a

patterned whole rather than as discrete stimuli. Perceptual processes include *closure*, the organization of ambiguous stimuli into closed figures; *figure and ground*, the discrimination of relevant parts of the stimulus field into figure and background; and *generalization*, attributing equivalence to similar patterns differing in detailed stimulus characteristics. Perception and learning are interdependent; the individual learns percepts by organizing factors in the immediate stimulus field according to past experience; then learned perceptual patterns aid in organizing new stimuli and facilitate learning.

Factors contributing to perceptual learning

In her extensive review of perceptual learning, Gibson[28] considered the conditions of learning which were effective in improvement. The *amount* or *frequency* of practice was found to be an important factor.[6, 12, 22, 34, 50, 63, 65] There was also some evidence that greatest effects occur early in the learning sequence, with decreased acceleration of the learning curve in later stages. However, this effect may be more marked where insight into the judgment problem is possible, as in the case of duration thresholds,[34] and less so where it is not, as in instances of response under dim illumination or brief tachistoscopic exposure of stimuli.

Reinforcement of correct responses, by means of information feedback, in the situation or provided by the experimenter, is another important factor. Information or knowledge of results is a basis for correction and may also provide effective reinforcement to the learner. It is possible for judgments to become more consistent in the absence of informational feedback without becoming veridical (that is, absolutely correct).[17, 58, 62]

The amount of information has also been shown to be a factor contributing to learning.[24–26, 64] For example, detailed quantitative reporting of errors is more effective than such information as right-wrong or over-under.

Still another factor is the distribution of practice. It has been shown[21, 33, 42] that the same amount of practice may be more effective if distributed over time than if massed.

Periodic reinforcement, after completion of a learning sequence, is effective in correcting errors which may creep in when regular reinforcement is discontinued.[21, 33] Finally, the sequence in which practice is given may be effective in learning, particularly when a conceptual scale is to be learned.

These conditions of learning are also modified by the motivation of subjects. In the study of Berens, Girard, Fonda, and Sells, motivational differences were believed to account for a substantial amount of the changes originally observed. Although none of the published reports has included measures of motivation of subjects, this is a most important variable which may be expected to contribute positively to learning achievement and retention.

Retention of learning

Hildreth, Meinberg, Milder, Post, and Sanders[21] were able to follow 11 of their improved patients from 15 to 23 months after completion of training. Five retained their improvement, while one showed less acuity than before training. Other investigators reported that improved visual acuity following training was retained in some subjects as long as two years.[45, 46] Dallenbach[15, 16] reported retention of span-of-apprehension in children 41 weeks after training. However, as Gibson has noted, the literature on perceptual learning is spotty with respect to retention, and only the following conclusions can be drawn: (a) that forgetting over time does occur; (b) that the degree of retention varies with the type of learning performance; and (c) that use of learned skills, motivation concerning maintenance, and possible additional factors are involved.

Forgetting is a dynamic process[2] and probably occurs most frequently in the case

of subjects who cease to use the skill as soon as practice is completed. On the other hand, in the case of motivated subjects such as those studied by Berens, Girard, Fonda and Sells, there is some reason to expect that a substantial number may continue their efforts to improve and thus retain their gains. These authors have not yet followed up any of their subjects. In this connection, the findings of Evans[21] and Horowitz and Kappauf,[33] showing that periodic reinforcement with knowledge of results tends to reinstate correct responses, suggest follow-up training techniques which may be of value.

Transfer of perceptual learning to new tasks

In addition to the question of retention, evaluation of training must also consider the problem of the extent to which perceptual learning in a particular training program can transfer or generalize to other visual tasks. This problem is of general importance in the use of training aids in all fields of training and has an extensive literature, beginning with the first scientific efforts to test the doctrine of "formal discipline" in education.

None of the recent studies of visual acuity cited examined this problem. However, Gibson reports that Renshaw[34] emphasized the transferability of tachistoscopic training, not only for reading, but for such activities as aircraft recognition, on the assumption that it trains a general "perceptual skill." Renshaw reported that Navy preflight trainees improved their skill at plane recognition by tachistoscopic training with digits and slides containing varied numbers of planes to count. Since no data were presented for a control group without tachistoscopic training, the experiment was repeated with an appropriate control group by Air Force psychologists.[32] They found that tests for recognition proficiency showed no advantage for the group which received tachistoscopic training, although their performance with digits and slides had improved. These and other[42,43] data suggest caution in making assumptions about transfer of tachistoscopic training to nonsimilar tasks without empirical evidence.

Gibson found that positive effects of transfer of perceptual learning were found in a variety of tasks; for example, from discrimination of shades of gray to discrimination of sound intensities,[11] from dart throwing at an underwater target to another situation[20,37] (employing the principle of refraction, learned in the original situation), from intensity scales to other intensity scales involving different ranges,[23] and others.[24–26,43,44,49] In general, transfer can be expected to occur most readily to similar tasks, but where "insight" is achieved in the understanding of a general principle, generalization is also possible.

Discussion

The possibilities of utilizing training in visual skills as an aid to ophthalmology, as noted by Lancaster in the selection quoted in 1944 and elaborated in this paper, present challenging problems for further research and application. Without advancing any encouragement to "get-rich-quick" schemes for curing all manner of visual disease by simple "do-it-yourself" procedures, we have nevertheless presented definite evidence that one phase of visual performance is trainable. That is the perceptual phase.

We have reviewed briefly the nature of perception, the reciprocal relation between perception and learning, the conditions of learning conducive to perceptual learning, retention of perceptual learning, and transfer to new tasks.

It seems possible that perceptual learning might occur even in the presence of a pathologic condition of the visual anatomy and that some of the claims discussed in this paper may represent such occurrences. If the consideration of perceptual learning as an important phase of the total visual process could be considered on its own merits, as contributing to improved visual performance, rather than as a vague nonspecific therapy for any eye defect, it may be ac-

cepted by ophthalmologists without suspicion.

The evidence discussed supports such qualified and enlightened acceptance. The improvement of many aspects of visual performance through perceptual learning is a fact. Problems of the motivation of individual patients, clinical indications for particular training, appropriate technique, and routine of training and follow-up should be studied with the same interest that has in the past been devoted to other problems in the field.

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THE EVIL EYE IN MEDICAL HISTORY

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Fascination has not always been a drawing room accomplishment. Until recent times fascination was the name given to a form of magic by which a gifted operator could influence the mental state or damage the physical state of his victim by speaking, touching, or merely looking. To fascinate, wrote Samuel Johnson in the 18th century, was "to bewitch; to enchant; to influence in some wicked and secret manner." The greatest danger was expected from the look of the fascinator, either alone or in combination with the other two methods. Francis Bacon was of the opinion that "fascination is ever by the eye."

The belief in the possibility of injury by vision is extremely ancient. A myth current in the long extinct, Mesopotamian civilization of Sumer during the third millennium B.C., and found inscribed with cuneiform characters on clay tablets, gave the goddess of the underworld the power to kill the goddess of love with a deadly eye. In Babylonia there was a class of demons which haunted deserts and graveyards, and which could injure men by a glance. All the Babylonian and Assyrian witches and wizards of the first millennium B.C. had this same power, and King Ashurbanapal of Nineveh had incantations available in the seventh century B.C. with which he could combat such dangerous glances.

The eye that could fascinate was known to the ancient Romans as the *oculus fascinus*. To modern Italians it is the *mal occhio*, while in Naples, where belief is still intense, the natives speak of *la jettatura*. All major languages have a word for what, in English, is called the evil eye, though in England and America other terms are now more commonly used. The owner of an evil eye may be called a "blinker," while the victims are said to be "blinked," "eye-bitten," "fore-looked," or "overlooked."

The belief in the evil eye, linked to the fear of demons and demon possession, had its origin in the dim past before the beginning of human records and among many different peoples. Long after its inception the belief was given a specious support by the theory of vision evolved by the Greek philosophers. They taught that visual rays were thrown out by the eye to strike external objects, from which the rays were reflected back to the eye. The opinion that vision was a form of energy originating in the observer persisted, though arguments were brought against it, till the beginning of the 17th century.

With time the belief in the evil eye underwent considerable elaboration. Mythical animals, like the basalisk of antiquity and the cockatrice in the Middle Ages, were believed capable of killing with a glance. Among men and women the evil eye, which might cause misfortune, illness, or death, appeared in two forms. The voluntary or moral evil eye was an attribute of witches and wizards, acquired by a pact with the devil, and used with conscious malice. The involuntary or natural evil eye was usually a congenital affliction, visited upon people who were far removed from diabolic associations, and who were often well disposed toward their fellow men. The popes Pius IX and Leo XIII were feared for their evil eyes, but were not blamed for any intentional wrong doing. In any case good fortune, wealth, and personal attractiveness were believed to draw the attention of an evil eye and to increase vulnerability, and those with most reason for feeling envious were most likely to be suspected of possessing an evil eye.

"Envy," wrote Frances Bacon, "emitteth some malign and poisonous spirit, which taketh hold of the spirit of another. Deformed persons, and eunuchs, and old men,

and bastards, are envious. For he that cannot possibly mend his own case, will do what he can to impair another's."

Antonio of Cartagena, professor of medicine at Alcala, wrote, in 1530, a book on pests and fevers which contained his opinion that the power of fascination was most apt to be given to old melancholic and hot choleric temperaments.

Various and wonderful are the effects which have been attributed to the evil eye. Any misfortune, particularly if unexpected or attended by mysterious or unusual circumstances, could be blamed on ocular fascination. Impairment of function, especially the sexual function, was most suspicious. Headaches, hiccoughs, and yawning were instantly recognized as symptomatic. Any disease might be transmitted by an evil eye, but particularly an eye disease when the fascinator was himself infected. For this reason Plutarch considered sore eyes the most infectious of all diseases.

"I saw a physician made blind while he was endeavoring to cure a patient with a disease of the eyes," wrote Roger Bacon in the 13th century.

In the 16th century, Fracastorius wrote that there was a kind of contagion which was transmitted not only by direct contact, but which could also infect from a distance. Like a blow from the eyes, he said, germs are shot out of sore eyes to carry the infection into the eyes of others. In the 17th century, Sir Thomas Browne expressed the same opinion, and added that the reflection of an inflamed eye in a glass was equally dangerous.

Engelbert, Abbott of Admont in Styria during the 14th century, believed that one who had been fascinated in any manner might never again see well.

When Charles Doughty traveled through Arabia in the 1870s he contracted an inflammation of his eyes from which many of the Arabs were suffering. A friendly native told him, "This is because thou hast been eye struck. . . . Certainly they have looked in your eyes. We have lookers (God cut them off) among us, that with only their eye-glances may strike down a fowl flying. . . ." The Rwala bedouins of northern Arabia believe that fascination causes failing vision, great weakness, fainting fits, difficulty in urinating, and that the victim is more likely to be bitten by snakes. On the skin over the heart of a fascinated child they expect a blue spot to appear; in the heart of a fascinated animal they expect to find a tumor as big as a fist.

To the evil eye has been ascribed all inflammatory eye disease, squint, nystamus, exophthalmos, and cataract. The same cause has been found for all congenital defects, fevers, convulsions, children's colic, smallpox, cholera, and that scourge of the Middle Ages, the Black Death, which probably involved several entities such as typhus, dysentery, and bubonic plague.

Michel de Montaigne, writing in the 16th century, thought that a violently agitated imagination could dart out infection through the eyes, while Nicolas Oresme, who died Bishop of Lisieux in 1382, held that the imagination may be so intense and deformed that the whole body is altered and, through the eyes, which are in close connection with the inner spirits, contaminate the surrounding air and other human bodies. Shakespeare was aware of these opinions when he wrote *Love's Labor's Lost.*

> Write 'Lord have mercy on us,' on these three.
> They are infected: in their hearts it lies;
> They have the plague, and caught it of your eyes.

Estimates of the mortality due to the evil eye reflect the extent of belief rather than a careful statistical analysis. Rab, a Hebrew scholar of Babylon in the third century A.D., blamed 99 out of 100 deaths on the evil eye. In Morocco two native proverbs give two different estimates: "The evil eye owns two thirds of the graveyard," and "one half of mankind die from the evil eye."

In general any condition of the eyes which appears to be abnormal or unusual may awaken the fear of the fascinator. Accusation has been brought against those with a ptosis

of one or both eyelids, with one eye missing, with inflamed eyes, or with a squint. Dark, lowering eyebrows are feared in Ireland, and eyebrows that meet over the nose in India.

Pliny the Elder believed, and quoted Cicero as also believing, that fascinators have a double pupil in both eyes, or a double pupil in one eye and the figure of a horse in the other.

Eye color may be sufficient to win a reputation for the evil eye, since it is not uncommon to find the two eyes differing in color as a congenital anomaly or as a result of iris infection. This is feared in Scotland. In Mediterranean countries eyes are usually dark in color, while in northern countries the reverse is true, and anyone whose eyes differ in color from those of his neighbors naturally comes under suspicion. This is the meaning of the Moroccan proverb, "Don't marry a blue-eyed woman, even though she has money in her box."

As "poor motherless Eve" has received the greater blame for the fall of man, so more women than men have been credited with the evil eye. Only in recent times have men become more conspicious as fascinators. Though difficult to explain there has been no lack of masculine explanations. Marcus Varro, in the first century B.C., attributed the evil eye of women to their unbridled passions. Women are the natural friends of the Devil, say the Moroccans. St. Thomas Aquinas, a noted authority on spiritual matters, specifically mentions little old women as prone to fascination because their souls are more vehemently moved to wickedness. Antonio of Cartagena was quoted in a book on the diseases of boys in 1611 as holding that old woman can fascinate more easily because the menstrual blood is retained in their veins. In this connection the acts of the Academy of Paris of 1739 recorded an experiment with an old woman. After she had gazed into a mirror a quantity of filth formed upon it which, on examination, was pronounced poisonous.

Not only on earth, but also in the heaven of antiquity, women were more likely to have the evil eye. Juno, queen of goddesses, was well known for it. Mercury, the messenger of the gods, needed protection from Juno and other celestial fascinators in order to serve all impartially and, for this purpose, carried the caduceus. The herald's wand, known as the caduceus, was a staff of olive wood, surmounted by a pair of wings, topped with a pine cone, and with two snakes coiled about it. Among other magical properties, the caduceus had the power of warding off fascination. Early in the 16th century it was introduced as the emblem of the medical profession by Sir William Butts, physician to King Henry VIII and his court, not that we might protect our patients in every possible way, but because it was thought to be a symbol of Aesculapius, the Greek god of medicine. However, the symbol of Aesculapius is a single serpent twined around a plain, rough hewn staff, and not the caduceus of Mercury.

Women, children, and domestic animals are particularly susceptible to the evil eye, and much more so when the women are beautiful, the children attractive, and the domestic animals healthy. With marriage, women face a time of great danger and among different peoples a great variety of ceremonies has been observed to give protection. No sooner has a woman passed safely through the perils of her wedding than she must take thought of the dangers attendant upon pregnancy and childbirth, when the evil eye may again seek her out to cause death, abortion, birth marks on the child, congenital defects, or the birth of monstrosities. The danger is thought to increase as pregnancy advances.

Thus the conception of the evil eye plays a part in the ancient belief in maternal impressions or prenatal influences. There are many stories of women frightened by the sight of some object or animal during pregnancy who later were delivered of a child on whose skin was marked in pigment a reproduction of the object or animal in miniature. Typical is a case reported in 1686 of a pregnant woman frightened by a mouse

whose child had the figure of a small mouse on its body. Pregnant Chinese women must avoid looking at a hare lest the child be born with a harelip.

A tale is told of how Hippocrates saved a princess, accused of adultery because her child was black, by putting the blame on a painting of a Negro which the husband had hung in his wife's room during her pregnancy. Thomas Fienus of Antwerp, 17th century professor of medicine at the University of Louvain, has recorded the story of a girl born near Pisa who was covered with hair because her mother at the time of conception was looking at an image of St. John the Baptist which hung by her bed. This last case would support Dr. Alfred Kinsey's opinion that human females are easily distracted during intercourse.

The *Boston Medical and Surgical Journal* in 1839 reported the case of an expectant mother, frightened by the gaze of a rattlesnake, whose child when born had an arm in shape and movement remarkably snakelike. The face and mouth resembled those of a snake, and the teeth suggested fangs. Any mention of snakes filled the child, at the time of the report a man aged 29 years, with horror and rage, and this last statement at least can be readily accepted. Some such report may have suggested the plot of *Elsie Venner* to Oliver Wendell Holmes. The heroine of this novel, published in 1861, exhibits snakelike characteristics because her mother had been bitten by a rattlesnake shortly before Elsie was born. To complete her character Holmes endowed poor Elsie with the evil eye of the snake which had bitten her mother.

In 1883 the *Medical Press and Circular* of London described a young man aged 21 years with congenital deformities of heart, skin, muscles, and bones attributed to the fact that his mother had been frightened during pregnancy when a guinea pig was thrust into her face. The *International Medical Magazine* of Philadelphia reported, in 1892, a child with deformed arms and legs whose pregnant mother was frightened by a large turtle. According to the *Belgian Medical Press* of 1879 a pregnant woman, fascinated by the antics of a circus clown, gave birth to a child with the clown's grostesque features.

That highly respectable British medical journal, *Lancet*, published numerous cases of visual prenatal influence; 1890 was a banner year, for in that year *Lancet* reported a mother, terrified by a bull, whose child was born with a cow's head; a mother, frightened by a black and white collie dog, whose child was born with a black mole studded with white hairs on the right thigh, and another over the left shoulder blade; and a mother, shocked by a crippled beggar, whose child was similarly crippled at birth.

When the Philadelphia ophthalmologist, Dr. William T. Shoemaker, wrote a monograph on retinitis pigmentosa in 1909 he considered the question of prenatal influences. Till proved otherwise, he thought, it must be conceded that "a sudden violent shock to the mother's nervous system, cognizance being through the sense of sight," might be a cause of retinitis pigmentosa in the child. In 1930 Dr. Shoemaker, then vice dean for ophthalmology in the Graduate School of the University of Pennsylvania, no longer taught his students at the Pennsylvania Hospital that prenatal influence could produce retinitis pigmentosa.

Though Havelock Ellis hesitated to reject prenatal influence altogether, the noted obstetrician, Dr. Joseph B. De Lee, toward the close of a long and distinguished career, stated that he had never found any plausible connection between a nervous shock to the mother and a deformity in the child. There is no connection between the nervous systems of mother and child, and the child is completely formed by the sixth week of pregnancy before the pregnancy is usually recognized, and long before the period of late pregnancy when the evil eye is supposed to be most effective.

Children are especially likely to damage

from the evil eye because, as Plutarch says, they have a "weak and soft temperature," or as St. Thomas Aquinas says, they have a "tender and most impressionable body," or as Roger Bacon says, they are "tender in age and complexion," or as Antonio of Cartagena says, they are of a "moist and tender constitution." With unexpected realism Antonio adds that it is often difficult to tell whether young children are fascinated or are suffering from sour milk.

Indirectly children do suffer from the evil eye. Throughout the Balkan countries peasant mothers wrap the heavy wooden cradles in thick woolen coverlets so that no evil eye or breath of fresh air can reach the child. Such a custom does nothing to reduce the high infant mortality, but when the child does grow sick or dies it is felt that, despite every care, the evil eye has prevailed. Similarly the peasant women of Egypt ascribe the hollow eyes, pale faces, swollen bellies, and scrawny arms and legs of their children to the evil eye rather than to malnutrition. Among the Jews of Tunis a baby was concealed from the evil eye behind thick curtains for some time after birth, and a smoking light kept burning day and night within the curtains.

Almost as universal as the belief in the evil eye itself is the fear that an envious or grudging look will poison food or rob it of its nourishment. "Eat not the bread of him that hath an evil eye, neither desire thou his dainty meats," says the Book of Proverbs. "The morsel which thou hast eaten shalt thou vomit up." In northern India no one would eat what another was looking upon with longing, for the food would either be vomited or cause sickness, while an Egyptian refused to buy from a butcher shop where the meat was hung in full view for every beggar to envy. The Moroccans believe that to eat before the hungry is to eat the poison of their eyes.

It is a pleasure to report that the Russians have already given this matter scientific consideration. In 1881, the newspaper *Illustriravinski Mir* informed the public that a convict under sentence of death had been turned over to the Russian Academy of Science in order to test the power of the evil eye on food. The prisoner was starved for three days with a loaf of bread before him which he could see but not touch and, sure enough, when the bread was analyzed it was found to contain a "poisonous substance."

To combat the dangers of the evil eye all the resources of magic and religion have been marshalled. Incantations and prayers, amulets and talismans, magic rites and manual gestures have been used in nearly all parts of the world for thousands of years.

Today the threat of the evil eye and the need for protective measures appear as pressing as ever. The *London Daily Express* in January, 1934, reported a man in Dorset had been fascinated and was slowly wasting away while modern medical science was unable to make a diagnosis or effect a cure. A magazine article published in 1956 described the people of mixed Spanish and Indian blood in the mountains of northern New Mexico who complicate the efforts of modern medical clinics established for them by opposing a belief in witchcraft. The doctors in the clinics must listen sympathetically to a mother's account of how the evil eye of a nurse or witch has made her baby sick, and they must attempt to include penicillin in the counterspell.

Dr. Benjamin L. Gordon, ophthalmologist and medical historian, practiced in south Philadelphia during the early years of this century among a population largely Italian in origin. One of his patients blamed a neighbor's evil eye for the constant yawning of a child because the neighbor had admired the child's skin and hair. Another patient thought her child was cross-eyed because a cross-eyed man had looked at her two days before the birth of the child. A medical colleague told Dr. Gordon of a child seized with hiccoughs after the visit of the mother's sister-in-law who had no children of her own and was naturally jealous. From a clergyman,

converted to a belief in the evil eye by his experiences, Dr. Gordon heard of a child attacked by fever and vomiting after the visit of a childless man who had the reputation of causing illness in the children upon whom he looked. In this particular case the clergyman wished to call a physician, but the mother insisted that only an evil eye specialist would know the proper treatment. Accordingly, an old man was summoned who put a skull cap on the child's head, laid his right hand on the cap, and mumbled an incantation or prayer.

Many of the patients and clinic secretaries at the Pennsylvania Hospital in Philadelphia, in whose clinics I have worked for the past 20 years, come from the same district in which Dr. Gordon began his practice. From them I have learned that the fear of being "overlooked" is widespread, and that there are many women throughout South Philadelphia who know the proper prayers against fascination, and are willing to relieve the depredations of the evil eye without any thought of remuneration.

Headache is a very common symptom for those who have been "overlooked," but general discomfort, weakness, fatigue, and stomach-ache are also possible, often preceded by an unpleasant sensation of warmth which gives warning that an "overlooking" has taken place.

In such an emergency the evil eye practitioner makes the sign of the cross and then, while marking a cross with the thumb on the forehead of the victim, mutters the appropriate prayers. If relief does not come within a half hour the prayer may be repeated but, if so, it must be done a third time, for, as in all magic rites, the odd numbers are more important than the even, and the number three the most important of all. If the attack comes on a Friday the cure must be administered on the same day or the symptoms will continue through the entire week end. When it is impossible to reach the practitioner in person the same results may often be obtained by sending a bit of jewelry or clothing worn that day, and over this the prayer will be intoned. Should there be any doubt about the cause of the symptoms this may be determined by dropping a little olive oil into a bowl of water. If the oil floats on top of the water no evil eye is at fault and a doctor of medicine can find a cure, but if the oil disperses into the water you have indeed been "overlooked" and had better consult an evil eye specialist at once.

I wished to learn what the prayers used in South Philadelphia against the evil eye might be, but I found that this could not be arranged. Such information is given only to those who will use it reverently, and even then the prayers may only be taught at midnight on Christmas Eve. It was possible, however, to buy evil eye amulets and in a little shop I found small, gold figures of crescent moons, popular in ancient Egypt, of hunchbacks, carried by Egyptians and Phoenicians, and of fish, which were often pictured on the armour of the Roman legionnaires to check the evil eyes of enemy soldiers.

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SOME BIOCHEMICAL CHARACTERISTICS OF HYDROCHLORIC-ACID INJURY OF THE CORNEA*

II. Carbohydrate metabolism

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Introduction

The acid-base tolerance of the cornea was reported by Friedenwald, Hughes, and Hermann.[1] They found that for unbuffered solutions the lowest concentration of acid tolerated by the intact rabbit cornea was a solution of pH 3.0. Buffered solutions with a pH value of less than 4.5 were not tolerated. Marked symptoms were noted when solutions of higher acid concentration were applied to this tissue.

The same authors, in 1946,[2] reported histopathologic studies of acid burns of the rabbit cornea. They concluded that acid burns were essentially nonprogressive and that late relapses were uncommon. The severity of the corneal lesion was directly related to the protein affinity of the acid anion. Further, anions with high protein affinity and protein precipitating ability produced corneal lesions at a higher pH than ions with low protein affinity. But anions with high protein-precipitating ability showed poor

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penetration through the corneal epithelium and poor diffusibility in the stroma. These authors suggested that the clinical and pathologic characteristics of acid burns of the cornea could be explained by such precipitation and denaturation of the proteins of the cornea.

These same authors also reported that, by their method of applying the injury, no loss of metachromatic staining or hexose-amine content of the cornea was noted.

The ascorbic-acid content of rabbit cornea has been shown to be significantly decreased immediately after injury by hydrochloric acid.[3] The ascorbic acid itself is apparently not destroyed, but it is released from its bound sites in the cornea and is washed away during the burning procedure.

It is the purpose of this paper to report investigations of changes in pH, turgescence, and carbohydrate metabolism in the rabbit cornea following controlled hydrochloric acid burns.

Methods

Animals. The animals used in this work were albino rabbits of the New Zealand White strain weighing from 1,500 to 2,500 gm. They were maintained on a diet of Gibbons Rabbit Pellets supplemented with approximately one-fourth pound of raw cabbage per day. Water was supplied freely.

Standard burning technique. The method for producing controlled burns to the cornea has been previously reported.[3]

Measurement of corneal pH. The rabbits were killed by air injection at various time intervals after the burning procedure. The corneas were excised and the surface moisture removed from these corneas by blotting with a clean cotton towel. The corneas were cut into small pieces with scissors and placed in a ground-glass homogenizer containing 1.0 ml. of distilled water. After mincing, the contents of the homogenizer were poured into a small beaker, the homogenizer washed with an additional 1.0 ml. of water, and the wash water was added to the homogenate in the beaker. The resulting mixture in the beaker was stirred and the pH immediately measured with a Beckman Model G glass electrode pH meter.

Corneal turgescence. The standard burning technique was applied to the right eyes of a group of rabbits, the left eyes serving as controls. At given time-intervals after the burn the animals were killed by air injection into the marginal ear vein and the corneas removed. Excess moisture was blotted off and the tissues weighed. These corneas were then placed in a Kjeldahl digestion mixture for conversion of nitrogen to ammonia by the conventional method. After proper dilution the ammonia was determined colorimetrically by the method of Borsook.[4] The ratio of wet weight of tissue to the weight of nitrogen was used as an index of turgescence of the cornea.

Anaerobic glycolysis. The manometric method of determining anaerobic glycolysis has been applied by deRoetth[5] in the study of the metabolism of normal cornea. The same method was used in this study. Nitrogen determinations were made on all tissues and the results were expressed as micrograms lactate produced/hour/mg. nitrogen. The determinations of lactate production were made for a period of two hours.

Oxygen uptake. The oxygen uptake of normal and burned tissues was determined manometrically at 37°C. Two different sets of experiments were performed. In one set no suspending medium was used, the corneas being placed into the dry Warburg vessel epithelial side up. In the other set a buffer suspending medium was used. The gas phase was air and the buffer, when used, was 9×10^{-3}M phosphate of pH 7.0. Rolled filter paper strips saturated with 50-percent sodium hydroxide were placed in the side-arm of the flasks to absorb dioxide. Four pooled corneas per flask were used to afford easily measurable amounts of oxygen utilization. When indicated the substrates lactate, isocitrate, and succinate were added to the medium so that the final concentrations

were 1×10^{-2}M, 3.8×10^{-3}M and 8.4×10^{-3}M respectively.

Results

Gross appearance of burned corneas. An opacity of the cornea was easily observable about 30 seconds after the application of the acid and this opacity became more pronounced reaching a maximum at 96 to 120 hours after onset of injury. The corneas stained with fluorescein for 72 to 90 hours after injury. Corneal swelling was easily observed by comparing the thickness of normal corneas with the burned corneas at any time period from 24 to 120 hours after injury.

pH of cornea. The results of the pH measurements of normal and acid-injured corneal minces are shown in Table 1. It is realized that the procedure used to measure the pH of the tissue allows some escape of carbon dioxide from the homogenates, yielding pH values which are certain to be greater than the true values. This method, however, should yield approximate values of pH of the injured tissue immediately after injury as well as the approximate time necessary for autoneutralization. To determine the averages of the various groups the pH readings were converted to hydrogen ion concentrations then averaged and the result reconverted to pH. By this means the corneas of normal animals showed an average of pH 7.8. This dropped to a value of 4.28 immediately after injury. By 15 minutes after injury this value had increased to 5.59 and was slightly more alkaline than normal within one hour after injury.

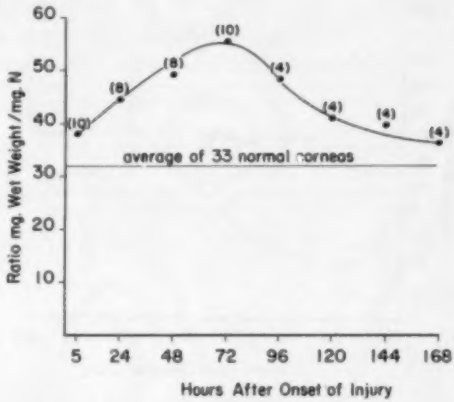


Fig. 1 (Guidry, Allen, and Kelly). Hydration of acid-injured rabbit corneas.

Corneal turgescence. The results of the turgescence experiments are shown in Figure 1. The average ratio for 33 normal corneas was 32 mg. wet weight/mg. nitrogen with an average deviation from the mean of ±2. The numbers shown accompanying each point on the figure represents the

TABLE 1

Values of pH of normal, and acid-injured rabbit corneas

Exp. No.	pH of Corneas					
	Normal Corneas	6 Minutes after Injury	15 Minutes after Injury	1 Hour after Injury	3 Hours after Injury	24 Hours after Injury
1	7.88	5.99	5.58	8.12	8.38	8.15
2	7.79	4.79	5.60	8.34	8.23	8.14
3	8.06	4.17		8.26	8.56	8.14
4	7.80	3.93		8.18	8.51	8.13
5	7.78	4.32				8.18
6	7.71	4.30				8.23
7	7.93	4.07				8.00
8	7.72	4.58				8.11
9	7.74	4.45				8.13
10	7.73	4.10				8.27
Average*	7.80	4.28	5.59	8.22	8.40	8.14

* Average = pH equivalent of average of hydrogen-ion concentrations.

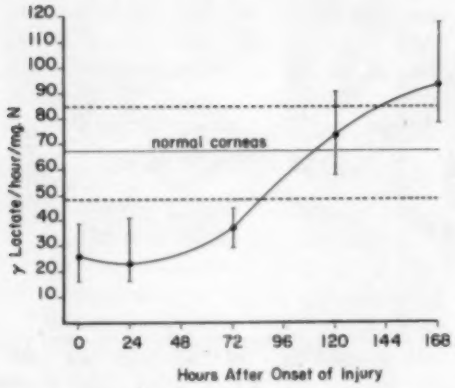


Fig. 2 (Guidry, Allen, and Kelly). Glycolytic activity of normal and acid-injured rabbit corneas.

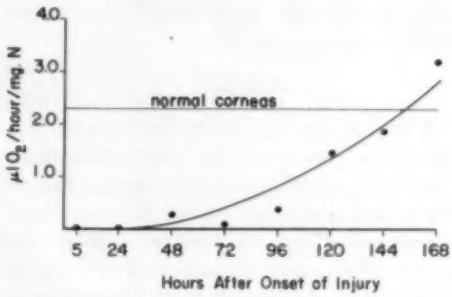


Fig. 3 (Guidry, Allen, and Kelly). Oxygen uptake of normal and acid-injured rabbit corneas. Determinations were without buffer suspending medium and reflect respiration of corneal epithelium only.

number of burned corneas used to determine these points. The average deviation from the mean at each point did not exceed ±5.0 percent. The average degree of swelling was barely perceptible at five hours after injury but increased steadily for 72 hours, after which there was a downward trend and a near normal value was obtained 168 hours after the burn. Gross observation thereafter revealed little difference between the injured and uninjured corneas.

Anaerobic glycolysis. The results of the anaerobic glycolysis experiments (with added glucose) are shown in Figure 2. It is seen that the glycolytic activity of the injured cornea was highly inhibited immediately after onset of injury. This activity rapidly increased and reached a normal value 120 hours after onset of injury. Each circle on the figure is an average of four determinations using two pooled corneas per determination. The lines bisecting each point gives the range of values obtained at each time period.

Oxygen uptake. The oxygen uptake of normal rabbit corneas (six determinations, four pooled corneas per determination) measured without a buffer suspending medium averaged 2.3 $\mu 10_2$/hour/mg. nitrogen with a range of values from 2.0 to 2.5 $\mu 10_2$/hour/mg. nitrogen. Injured corneas (fig. 3) showed no appreciable oxygen uptake for 24 hours after injury and only slight oxygen uptake during the period 48 to 96 hours after onset of injury. The oxygen uptake at 120 hours was somewhat more than half normal and reached near normal values 144 hours after onset of injury. Since, in these experiments, the endothelial surfaces of the tissues were in contact with the bottom of the Warburg flasks, it was assumed that any oxygen uptake shown was due to respiration by the epithelial layer. Each point on the curve is an average of four determinations of four pooled corneas per determination. The average deviation from the mean did not exceed more than ±8.0 percent in any of the groups.

The average oxygen uptake of normal rabbit corneas (64 corneas—16 separate determinations) using the buffer suspending medium was found to be 4.4 $\mu 10_2$/hr./mg. nitrogen (table 2). The acid burn immediately affected the oxygen consumption; this value dropped to an average of 2.0 $\mu 10_2$/hr./mg. nitrogen, or 45 percent of normal. This value remained low for 72 hours then rose to a value which was almost normal 168 hours after onset of injury. The addition of substrates failed to alter significantly the oxygen uptake of the burned corneas.

Discussion

The opacity which forms in the cornea immediately following acid injury does so

TABLE 2

OXYGEN UPTAKE OF NORMAL AND ACID-INJURED RABBIT CORNEAS

(Determinations were in buffer suspending medium with substrates added as indicated.)

	Average O_2 Uptake $\mu l O_2$/hr./mg. N*				
Hours after Onset of Injury	Normal	No Substrate	Lactate	Isocitrate	Succinate
	4.4				
0		2.0	1.5	1.7	0.6
24		1.4	1.5	1.0	1.4
48		—	1.7	1.0	1.5
72		1.3	—	—	—
96		2.1	1.5	1.9	2.2
120		2.6	2.2	2.7	2.8
144		3.2	—	—	3.5
168		3.8	—	—	—

* Each value is an average of four determinations with four pooled corneas per determination.

before any appreciable swelling can take place. The pH of the acid solution dropped on the cornea is approximately 0.20, a value much lower than that tolerated by tissue proteins. It seems logical therefore to conclude that the initial opacity after the injury is due to the acid denaturation of proteins. Later, however, from 24 to 120 hours after onset of injury, the opacification increases. During this same period the cornea swells markedly and therefore one could reasonably expect that the opacification is principally due to the hydrated state of the tissue. Another fact which leads to this conclusion is that the corneal epithelium containing the acid-denatured proteins usually sloughs 24 to 30 hours after injury.

These injured corneas were stained upon application of a one-percent fluorescein solution for 72 to 90 hours after onset of injury indicating that migration of the corneal epithelial cells was not complete until that time.

Measurements of the pH of the tissue after injury, crude though these may be, indicate that the acid is neutralized by the cornea very shortly after this injury. It is doubtful that the injurious effect of the acid can last for more than one hour and probably does not last that long.

The corneal swelling probably begins shortly after the onset of injury but does not become apparent for 24 hours. Two factors are present from these experiments which logically explain this swelling. In the first place, the corneal epithelium is destroyed and sloughs some 24 to 30 hours after onset of injury. This destroys a barrier which is normally impervious to electrolytes and therefore can be expected to be of some importance in osmotically maintaining the normal turgescence of this tissue. Further, it has been shown by Schwartz et al.[6] that the maintenance of the normal hydration of the cornea is metabolically dependent and swelling will occur during the inhibition of oxygen uptake by oxidative inhibitors. The acid injury very severely inhibits the oxygen uptake of the epithelium and therefore probably affects the supply of energy necessary to maintain the normal state of hydration.

The glycolytic activity of the tissue is immediately inhibited by the injury. This activity remains low for 24 hours and then slowly increases, reaching normal values from 96 to 120 hours after onset of injury. It is slightly above normal 168 hours after onset of injury, a time when the oxidative system of the tissue has not quite returned to normal. This slight elevation of glycolytic activity may be a reflection of the tissue obtaining a greater portion of its energy from glycolysis to supplement that unob-

tainable by oxidation.

The inhibition of glycolytic activity during the early recovery phase cannot be due to the lack of glucose as a substrate, since this material has been added to the medium before the measurements begin. It must therefore be concluded that all or part of the glycolytic enzyme system (either proteins or cofactors) in the anterior portion of the cornea is destroyed by the injury and this is responsible for the inhibition of glycolysis.

The oxygen consumption of the cornea is also immediately inhibited by the injury. The oxygen uptake decreased to roughly one third that of the whole normal cornea and that is the portion of oxygen uptake usually ascribed to the endothelium.[7] Indeed, the experiments designed in such a manner that the endothelium was in contact with the bottom of the dry Warburg flask and therefore had no access to oxygen, revealed that acid-injured corneas showed no appreciable oxygen uptake for 96 to 120 hours after onset of injury.

It can therefore be concluded that the injury as applied completely inhibits the oxygen uptake of the corneal epithelium. Furthermore, assuming that the cornea contains a typical cytochrome oxidase system, the inhibition is not due to lack of substrate since the addition of substances normally oxidized by the three portions of this system (lactate through the diphosphopyridine nucleotide portion, isocitrate through the triphosphopyridine nucleotide portion, and succinate through the succinoxidase portion) failed to restore the oxygen uptake.

It must be concluded therefore that oxygen uptake is inhibited or destroyed in the corneal epithelium as a result of general enzyme denaturation. This function of the corneal epithelium begins appreciable regeneration 96 to 120 hours after onset of injury and this regeneration is virtually complete 168 hours after onset of injury for burns of the severity applied in these experiments.

Summary

1. The pH of rabbit corneal tissue is severely lowered when burned for one minute with 1.0 N hydrochloric acid. The pH is rapidly returned to within physiologic range by the natural buffering mechanisms of the tissue.

2. Hydration of the corneal tissue is easily measurable 24 hours after onset of injury and continues to increase until 120 hours. This is followed by a decrease in hydration until normal values are obtained approximately 168 hours after onset of injury.

3. Glycolysis of the tissue is markedly inhibited immediately after the injury as is the oxygen uptake. This inhibition of metabolic activity has been shown to be due to destruction of the enzyme systems involved, and not necessarily to an inavailability of substrate. This inhibition of metabolic activity is probably limited to the corneal epithelium and possibly to the very anterior portion of the corneal stroma.

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STENOSIS OF THE CANALICULUS FOLLOWING IRRADIATION THERAPY*

Management of epiphora

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Irradiation therapy for a malignant lesion near the inner canthus frequently produces stenosis of the lacrimal canaliculus. Nevertheless, there probably are roentgenologists and oculists, too, who are not aware of this danger. There is no unanimity of opinion as to the most desirable method of treatment for a malignant lesion of the eyelid; but, regardless of the method of treatment, a pathologic diagnosis should be obtained for any new growth of the eyelid or contiguous region.

In the region of the inner canthus, basal cell carcinoma ocurs more frequently than other malignant tumors. For satisfactory management, surgical excision usually is preferable to irradiation therapy. After removal of the lesion, a pathologic diagnosis should be made from sections of frozen tissue. Then, if indicated, wider surgical excision should be accomplished immediately. If the surgical wound is large, skin grafting may be desirable. Usually, a free graft from the upper eyelid will suffice.

Irradiation therapy may be desirable for some malignant lesions in the region of the canaliculus. Because of the rich lymphatic system of the inner canthal area, squamous cell carcinoma may metastasize early. In this event, irradiation therapy with or without surgical excision frequently is indicated. Also, one or both of the canaliculi may be involved by direct extension from the malignant lesion. In this type of patient, Beard[1] has found it useful to keep a length of polyethylene tubing in the inferior canaliculus during X-ray therapy and until the reaction from irradiation subsides. When there is a possibility of damage to the canaliculus from surgical excision or from irradiation, the patient should be advised of the likelihood of epiphora.

Malignant lesions occur more frequently on the lower eyelids than on the upper, and, consequently, stenosis of the lower canaliculus from irradiation therapy is seen more often. Since the lower canaliculus is more important in the normal drainage of tears, epiphora is more pronounced when the lower canaliculus is occluded. Following irradiation, stenosis of the common punctum will block tear drainage completely.

Treatment

Because stenosis of the canaliculi following irradiation therapy is so varied in extent and severity, treatment must be varied. Other disorders such as ectropion may complicate the situation. Nevertheless, any procedure to relieve epiphora is more likely to be successful if the natural drainage channels can be re-established.

If only one canaliculus is stenosed and the other is functioning properly, the patient may complain little of epiphora. Obviously, this type of patient should not be treated. Occasionally, however, both canaliculi are occluded so severely that a conjunctivodacryocystostomy, canthocystostomy, or a canthorhinostomy may offer the only hope for relief of the annoying epiphora. Relief of epiphora following any of these procedures usually is not as complete as when the canaliculi are functioning again.

If the stenosis of the canaliculus is of recent origin and the passage can be opened with a probe without too much difficulty, insertion of polyethylene tubing[2] through a

* From the Department of Ophthalmology of the Scott and White Clinic, the Scott and White Memorial Hospitals, and Scott, Sherwood, and Brindley Foundation.

special thin-walled needle may suffice. If stenosis is limited to the region of the common punctum, this obstruction usually can be forced open and a short piece of polyethylene tubing sutured into position.

Technique

First, an incision should be made through the tear sac. Because the common punctum lies deep to the canthal ligament, this incision must be made higher than an incision for external dacryocystorhinostomy. Second, after the tear sac has been entered, a probe should be passed through the lower canaliculus, forcing an opening through the common punctum. Polyethylene tubing then is threaded through the lower canaliculus into the tear sac through a special thin-walled needle. This tubing then should be drawn medially and out at such a length that about 2.0 or 3.0 mm. will lie to the medial portion of the canaliculus with about 2.0 mm. in the tear sac. This can be sutured in place easily with silk (6-0), and the skin incision closed. The polyethylene tubing should be left in position permanently.

Frequently, polyethylene tubing cut the length of the lower canaliculus will stay in position indefinitely. By this method the tubing is buried in the canaliculus and no anchoring is necessary. It should extend from the medial wall of the tear sac to the lateral bend of the canaliculus.

Occasionally, stenosis of the lower canaliculus is limited to the region of the punctum. This type of stenosis usually results from direct extension of a tumor or from treatment of a tumor, and a properly performed three-snip operation[3] may offer simple and effective relief. In performing the three-snip operation, it is well to remember to rotate the scissors toward the eyeball so that the first snip will involve the conjunctiva only and not the lid margin. Also, this snip should not be over 2.0 mm. in length.

Case reports

Case 1

A man, aged 53 years, developed epiphora of the left eye following radium therapy for extensive carcinoma in situ of the ethmoid region. With some difficulty, the lower canaliculus could be dilated, and polyethylene tubing was inserted into the lower canaliculus through the punctum. This tubing was strapped to the cheek for several days.

Because the epiphora had existed for only a few days before the tubing was inserted, the possibility exists that spontaneous relief might have occurred without treatment. Nevertheless, the patient has remained free of epiphora for the past seven years.

Case 2

About two years prior to observation, a 63-year-old woman received roentgen-ray therapy for skin cancer located in the region of the inner canthus of the left eye. A few weeks following this irradiation therapy, epiphora occurred and continued unabated. Examination revealed a whitish area of skin about 3.0 cm. in size in the region of the inner canthus. The upper and lower canaliculi of this left eye were stenosed completely at the common punctum.

An incision was made through the skin into the upper third of the lacrimal sac. A probe was passed into the lower punctum, and, with the use of considerable force, the obstruction at the common punctum was opened. A polyethylene tube was inserted, the medial end projecting about 2.0 mm. into the tear sac, and the remaining 2.0 or 3.0 mm. lying in the medial portion of the lower canaliculus. This was sutured into position by passing silk (6-0) through the wall of the polyethylene tubing. Then, to anchor the tubing in place, the suture was passed through the soft tissue of the lacrimal sac near the common punctum. Fluorescein was instilled within the conjunctival sac and it ran freely into the nose.

Four months have elapsed since the operation, and the epiphora has been markedly improved since insertion of the tubing.

Case 3

Two years ago, a woman, aged 56 years, received roentgen-ray therapy for skin cancer near the inner portion of the left eye. Epiphora was noted soon after irradiation therapy was completed.

When observed, the skin near the inner canthus had the typical blanched appearance. The lower canaliculus was patent to the region of the common punctum, but the upper canaliculus was patent only in its lateral 2.0 or 3.0 mm. Both puncta were small.

A procedure similar to that used in Case 2 was planned. However, after opening into the tear sac, it was found that the nasolacrimal duct also was occluded. An anastomosis was made into the nose similar to that of an external dacryocystorhinostomy. Polyethylene tubing, extending from the

medial 2.0 or 3.0 mm. of the lower canaliculus through the anastomosis into the nose, was sutured and left in position.

As the patient lived some distance away, observation and treatment were made difficult and relief was only partial.

CASE 4

Eleven months prior to observation, a 49-year-old man was treated with both roentgen-ray and radium therapy for skin cancer near the inner portion of the right eye. A constant, annoying epiphora developed within a few days following irradiation therapy.

At examination, marked epiphora was obvious. The skin was blanched near the inner canthus. Both puncta were closed almost completely, but could be dilated. A probe could be passed into the lower canaliculus for a distance of only about 4.0 mm. Fluid could be flushed through the upper canaliculus into the nose. The upper canaliculus was slit downward to the lacrimal lake region and a modified three-snip procedure was performed. This established a punctum at a lower level.

When observed a few weeks after the operation, the patient had not experienced complete relief of the epiphora. In this case, if the upper punctum had been patent the epiphora probably would have been slight and surgical treatment unnecessary.

SUMMARY

Stenosis of the lacrimal canaliculus frequently occurs following irradiation therapy for malignant lesions of the inner canthal region. In general, basal-cell carcinoma occurring in the region of the inner canthus should be removed surgically. However, if irradiation therapy is used for this or other malignant lesions, the patient should be warned of the possibility of annoying epiphora. Because the extent and severity of postirradiational occlusion of the lacrimal canaliculus varies, the treatment must be varied. Complete relief from epiphora may be difficult, but several methods of treatment have been suggested.

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EYE: AN ETYMOLOGIC NOTE

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It is unnecessary to point out to the ophthalmologist the importance of the eye as a sense organ. His choice of specialty and his daily practice bespeak his evaluation of its importance. As for its value outside ophthalmology, even a cursory reflection on the Bible, legend, literature, history, and everyday language reveals the significance of the eye to all men in all ages in all civilizations. My purpose here, however, is not to review the import of the eye as an organ of sight to mankind but to note in random fashion how the words for *eye* pervade the day-to-day concepts in many languages.

There is no point in discussing the Greek and Latin derivatives of words for *eye* known to ophthalmologists, as well as to specialists in other branches of medicine, for these words have a long familiar history. These terms devised for diseases, techniques and apparatus have clear meaning and require no explanation here. For example, ophthalmia, ophthalmoplegia, amblyopia, diplopia, oculomotor, oculogyric, binocular, optic, horopter, and myriad others. Instead, I plan, in these notes, a casual meandering through the less scientific words which have as their basis the concept *eye* and also through familiar words which cloak the Greek *op-* and the Latin *ocul-* in unfamiliar garb. In

addition, I shall give some gleanings from more exotic languages.

The degree to which the eye invades our common expressions gives living proof of what we think of it and how often our thoughts about it give voice to its indispensability in function and appearance. Here are some common English (American) expressions using the word *eye:**

eyed (verb)
eyeballer (a meddler)[2]
eye-opener
eyeshot
eyesight
eyesore
eyewitness
bright-eyed (alertness)
cock-eyed
dreamy-eyed
fishy-eyed
green-eyed (jealousy)
hawk-eyed (keenness)
red-eye (whiskey)[3]
red-eyed (angry)[4]
wall-eyed (a horse with a "china eye")[5]
wide-eyed (amazement)
apple of my eye†
evil eye
eyes of Texas
eyes right (military command)
my eye! (disbelief)
an eye for an eye
an eye for (business, a pretty face)
an eye to the main chance
anyone can see with half an eye
before [ ] very eyes
can't take eyes off
cast sheep's eyes at
[ ] eyes are bigger than [ ] stomach
feast [ ] eyes on
in [ ] mind's eye
in a twinkling of an eye
keep an eye on
keep a sharp eye out for
make eyes at
see eye to eye
sight for sore eyes
the whites of their eyes

Eye is used also in the following terms with an emphasis on resemblance to the organ: Eyelet, hook and eye, buckeye, eye of a needle, eye of the wind, eye of the storm, eye of a hurricane, eyes of a ship, eyes of the rigging. The canine teeth, however, are called eyeteeth "because their fangs extend upward nearly to the orbits of the eyes."[2]

The English word *eye* comes from the Middle English *eye* or *eighe*, related to the Old Mercian *ēge* and the Anglo-Saxon *ēage*. These are all cognate with the Dutch *oog*,* Icelandic *auga*, Danish *øie*, Swedish *öga*, Gothic *augō*, and the German *Auge*. It appears moreover to be related also to the Sanskrit *akshi*, Greek ὄσσε (osse), Latin *oculus*, Lithuanian *akis*, Russian *oko*,[4] and the Irish *ugail*.[5] All of these forms regardless of spelling are phonetically related and probably come from an ancient root AK of which more will be said later.[6]

Two common English words with *eye* disguised are *daisy*† and *window*. *Daisy* is from the Middle English *dayësyë* which is in turn from the Anglo-Saxon *dæges ēage*, "the day's eye," that is, the sun which the golden center and white petals (the rays) resemble.[10] *Window* is Scandinavian in origin, literally "wind eye," an eye or hole for the admission of air and light, from the Icelandic *vindauga*.[11] Comparable to this is the Russian word for window, *okno* derived from *oko*, the word for eye mentioned above.[12]

The ancient root AK from which the word for eye in all the various Indo-European languages given above are derived, meant "to see" and was probably identical in origin with another root AK meaning "to pierce," "to be sharp," or "to be quick." This is believable if we consider the keenness of the eye, its flashing perceptions, its glints. This root appears in the Greek ἄκρος, *akros*, meaning "pointed." This gave the

* The American Thesaurus of Slang gives more entries under EYE than under any other anatomic part of the body and comparably under the entry SENSATION, "Sight" has a greater number of references than any other sensation.[1]

† Compare with this the German word for eyeball, *Augapfel*, literally "eye-apple." It has an anatomic significance as well as a metaphoric use of "darling" or "precious" similar to "apple of my eye" in English.

* From this word, according to Skeat, we get the word "ogle."

† Other flowers whose names contain words from various parts of the body are: Carnation from the Latin word for flesh, so named because of the flower's pink or flesh color; dandelion from the French *dent de lion*, "lion's tooth" from the tooth-like leaves; hepatica from the Greek word for liver in reference to the shape of its leaves; nasturtium from the Latin *nasus*, nose, and *torqueo*, twist, in reference to its pungent odor which "twists the nose"; orchid from the Greek *orchis* meaning testicle, so named for the double roots which resemble the testes.[7] Digitalis from the Latin *digitus*, finger, refers to its fingerlike corolla.[8] Eyebright or eyewort was the name of a plant formerly used as a remedy for eye disease.[9] Black-eyed Susan needs no elaboration.

noun ἄκρον, *akron*, "a height" from which we get acrophobia, acrobat, Akron, acropolis, and ἀκμή, *akme*, meaning "a point" or "edge" (acme). The root is also in the Latin *acus*, "needle" (acupuncture, acute, acid, ague), and *acer*, "keen, sharp" (acerbity, acrid, exacerbate, vinegar). Akin to these are the Anglo-Saxon edge, egg, ear, and axe.[13] Except for the English *eye*, the only forms of the root AK of major importance are the Greek and Latin.

The Greek form ὄσσε, *osse*, already referred to above, was used in Greek to denote the two eyes together rather than each as an organ. Another word for eye from the standpoint of its function in vision was ὄμμα, omma.* This word, like ὄσσε, appeared more frequently in poetry than in prose and was used in such expressions as "to look straight at," "face to face," "in full sight," "out of sight," "before one's eyes," and so forth, in which the emphasis is on the act of seeing. It was used also to represent the object seen or a sight, as well as a phantom or a fancilful image. Also, it was used figuratively to denote the moon as the "eye of night" or the sun as the "eye of day," a familiar metaphor among all peoples. The next logical step in view of its organic importance was its use to denote anything dear or precious.[14]

In addition to ὄσσε and ὄμμα, a third Greek form is the one more familiar to medicine: ὀφθαλμός, *ophthalmos*. In Greek there was little difference in the usage of this form and ὄμμα, for ὀφθαλμός also appears in the same sort of expression and, like ὄμμα, could be applied to "the dearest, best, as the eye is the most precious part of the body, hence of men." "In Persia ὀφθαλμός βασιλέως, *ophthalmos basileos*, the king's eye, was a confidential officer through whom he beheld his kingdom and his subjects."[15]

The Greek verb ὁράω, horao, "to see," appears in medical terminology in many forms.[16] The verb was irregular in its various tenses and voices, thus giving us numerous bases for derivatives: *op-*, *ops-*, *opt-*, *ophth-*, *id-* or *eid-*, and *-orama*. In medical nomenclature when the eye as an organ is involved the form *ophthalm-* seems to be preferred (ophthalmia, enophthalmos, exophthalmos, anophthalmos, ophthalmoplegia). When the function of vision is implied the *op-* and *ops-* forms are preferred (anopia, scotopia, myopia, nyctalopia, micropsia, photopsia, chromatopsia). When measurement of vision is concerned the form *opt-* is usual (diopter, optics, optician, optometry).

Obviously there are exceptions which cut across these groups. The medical derivatives from *eid-* or *id-* (from which we get idol, idyllic, idea) are fewer and seem to be directed more toward perception or form, that is, the object seen rather than the person seeing or the act of seeing (eidetic, eidoptometry). A modification of these, *-oid*, coming from the word for "form" or "shape," εἶδος, *eidos*, is used as a suffix to denote similarity or likeness (erysipeloid, pemphigoid, mucinoid, ovoid). Still a final form appears in English from the present tense *ora-:* diorama, cyclorama, panorama, and so forth.

The greatest number of derivatives, some apparent and some in disguise, come from the form *ops*, ὤψ or ὄψ. The original meaning of each was "eye" but by obvious extension it came to mean "face"[17] for the eyes are clearly the dominant feature of the face giving it expression and countenance. The word *antelope* seems to be a corruption of the Greek ἀνθάλωψ, anthalops, "bright-eyed" from ἀνθεῖν, *anthein*, "to shine," and ὤψ.[18] Originally the base word ἄνθος, *anthos*, was "a flower" (as in chrysanthemum, the golden flower) and the color of blossoms lent to it a later meaning of brightness. *Canopy*, an overhead covering, entered the language through the Italian and by misspelling into the French as *canapé*. The original Greek was κωνωπεών, *konopeon*,

* It is from this ancient Greek word in the plural, ὄμματα, that the modern Greek word for eye, ματι, is derived.

an Egyptian bed with a mosquito curtain. The stem κώνωψ, *konops*, meant "a gnat" or "a mosquito," literally "cone-faced," that is, an insect with a cone-shaped head. Thus *canopy* is a protection against a cone-faced insect.[19]

The French *canapé* was originally a sofa with a canopy netting. The current meaning of a tiny bite-sized wafer decorated with cheese, meat, or other paste evolved, I presume, in reference to the tasty "covering." Europe was named for *Europa*, Εὐρώπη, the daughter of a Phoenician king beloved of Zeus and wooed by him in the guise of a bull. Her name comes ultimately from the Greek εὐρύς, *eurys*,* "wide" and ὤψ, "wide-eyed" in reference to this aspect of her beauty.[20] The *Cyclops* of course were the one-eyed giants whose eye was placed in the middle of their forehead, *cycl-* and *ops*, "round-eye." The Ethiopians, literally *aithi-* and *ops*, "burnt-face,"† were so named when their faces became burned by the sun-chariot driven too close to earth by Phaëton.[21]

The Latin word *oculus* gives us in addition to the obvious ophthalmologic or optometric terms (ocular, monocle, binocular, and so forth) several less apparent. *Inoculate* was literally "to insert a graft," that is, *in* and *oculus*, for *oculus* meant not only "eye" but also "the bud of a plant" which it somewhat resembled[22] (compare the "eye of a potato").

In French the word for *blind* is *aveugle*, coming from the Latin *ab*, "away from" or "without" and *oculus*. From this in turn we have gotten *inveigle*,[23] to deceive a person into doing something by not revealing the whole truth to him, in a sense by "blinding" him.

Even less apparent is our word *antler*. The Old French was *antoillers* which came from the Latin *ante*, "before" or "in front of" and *oculus*, quite properly from the location of the horn.[24] Horatius Cocles, who in legend defended the bridge alone, was literally Horace the One-Eyed for the word *Cocles* is derived from an old root SCA meaning "darkness" or "shade" and *oculus*, thus "blind in one eye."[25] Some etymologists think that the *oculus* root appears in such adjectives as *ferox* (from which we get ferocious) and *atrox* (from which we get atrocity), being derived respectively from *ferus*, "wild" and *oc-*, "wild-eyed" or "fierce-eyed" and *ater*, "dark," "somber," and *oc-*, "terrible-eyed" or "dreadful-eyed."[26]

Just as in the Greek and Latin derivatives, the descriptive and figurative concepts of the eye carry over into the languages of African peoples and people of the Pacific Islands.

In Malaya, for example, *mata* is the eye or figuratively the center. *Mata kayu*, "wood-eye" is the word for "knothole"; *mata kaki* is the ankle bone, meaning "eye of the foot (leg)"; *mata susu* is the nipple, the "eye" or "center" of the breast.[27] *Mata mata*, that is, "plural eyes," "many eyes," is the word for *policeman*, someone I presume with eyes everywhere. It is not surprising then that *mata-mata gelap*, a "dark" or "secret" eye would be the expression for "detective,"[28] a private eye as we are wont to say. *Mata hari* is Malay for "sun," the "eye of day,"[29] a metaphor common to all languages. Little wonder the famous spy of World War I chose that as her name for she was indeed an eye by day if not as glorious as the sun. *Mata pisau* for the cutting edge of a knife[30] is not unlike the Latin *acies* for the cutting edge from the root AK given above on page 252.

The Malayans use *anak mata* for the "pupil of the eye." Literally this is the "image" or "doll" in the eye.[31] This is comparable to the word "pupil" itself which comes from the Latin *pupula*, in turn from *pupilla*, "little girl," a tiny image appearing in the eye.[32] The Malayans go even farther since they have an expression to cover the

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* Shipley (op. cit., p. 144) gives also εὐρώς, mould, in reference to the fertile earth but he deems this rather far-fetched.

† Shipley (op. cit., p. 143) prefers Ethiopia as an adaptation of the native Egyptian *Ethaush*.

image in the pupil of the eye, *orang-orangan mata.*[33] The word *orang* means "man" and appears in the word *orang-utan,* "a wild man," used also by them for a boor. The Greeks call the pupil of the eye γλήνη, *glene,* and on account of the diminutive reflections it gave applied the term to small children. Curiously enough in Tahiti, the pupil is *hia mata,* the "mirror of the eye."[34] The Masai* of Africa are less fanciful about the pupil. They call it simply *nerok ngong,* "the black of the eye."[35]

The Hawaiian word for eye, *maka,* similar to the Malayan, is used also for face, point, edge, just as are the Indo-European roots given on page 254. The stem for *eye* is apparent in *makahiamoe,* drowsy (*hiamoe,* "sleep"); *makaki'i,* mask; *makapa'a,* blind in one eye (*pa'a,* "tight" or "secure"); *makapo,* completely blind (*po,* "night" or "darkness"); *makapouli,* to be faint or dizzy (*pouli,* "dark" or "obscure"); *makawai,* tears or small outlets for water (*wai,* "liquid" or "fresh water"); *maka'i,* guard; *maka'ikiu,* detective.[36]

From these gleanings from dictionaries and other sources we can see how the words for eye in many languages have figurative meaning. Although these notes fall far short of representing a comprehensive enquiry into all the expressions for eye in all languages, as random thoughts they do demonstrate the importance of the organ in linguistic or semantic development.

3416 Tulane Drive.

* The following Masai words are equally matter of fact: eyebrows and eyelashes are *elbabit ngongo,* "the hairs of the eye" and the upper eyelid, *shomata ngong,* "the roof of the eye."

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Ophthalmic Miniature

I might, indeed, cite many tragical instances of men of talents, and of extraordinary volubility, who have brought on themselves a weakness of sight approaching to blindness, and which has unfitted them for their various functions, merely from having made an improper use of their eyes, after the exertion of public speaking.

* * *

I have noticed among many artists, a most pernicious contrivance of globes, or spheres of glass, filled with pure water, in order to augment the light. Such balloons cannot fail to be most detrimental to the sight, if placed upon a work-table where the daylight passes horizontally; to be convinced of this, it is only necessary to refer to what I have already said with regard to the partition of light, or to look for a few minutes at one of those spheres of coloured fluids, which are so ostentatiously placed in the shop-windows of chemists and apothecaries in the metropolis, who might be supposed bribed by the oculists and surgeons to destroy the sight and break the limbs of the unfortunate passengers exposed to their influence.

* * *

An eighth rule is for a humbler class of society, and is, that all artizans who work at a blazing fire, ought often to wash their eyes with cold pure water.

An attention to this will not only render them fitter for their work, since the eyes, when refreshed with cold water seem to acquire new vigour; but it will also tend to take off some of the dangerous affects produced on the eyes, sooner or later, by the heat of a constant blazing fire and light. In support of this, I can say that farriers and blacksmiths, whitesmiths and cooks, are often subject to blindness, or partial defect of vision in advanced life.

H. Colburn, London, 1816,

The Art of Preserving the Sight Unimpaired to an Extreme Old Age.

NOTES, CASES, INSTRUMENTS

THE MALIGNANT CARCINOID SYNDROME (ARGENTAFFINOMA)

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Recently a clinical entity referred to as the malignant carcinoid syndrome has appeared in the literature.[1-3] It is described as consisting of generalized flushing, cyanosis, chronic diarrhea, respiratory distress, carcinoid of the small intestine, and valvular heart disease. To this description I should like to add two more findings of particular interest to the ophthalmologist. These are a bluish discoloration of the conjunctivas and oral mucosa and cataractous lens changes.

It is believed that the chromaffin cells of the gastrointestinal tract are endocrine organs and that they secrete a substance known as serotonin. Some authors have suggested that the syndrome might result from the secretion of serotonin.[4,5] Carcinoid tumors are thought to be derived from enterochromaffin or argentaffin cells. Serotonin is a vasoconstrictor substance derived from the amino acid tryptophan.[6,7] In the presence of hydroxylase, tryptophan is converted to 5-hydroxytryptophan and in turn to 5-hydroxytryptamine(serotonin) by a decarboxylase. The blood serotonin levels of carcinoid patients were shown to range from 0.5 to 2.7 μg per ml., compared to normal values of 0.1 to 0.3 μg per ml.[8] The findings in the syndrome are undoubtedly due to an excess secretion of serotonin combined with an alteration of tryptophan metabolism resulting in a change in niacin and protein production.

CASE REPORT

The patient, a 39-year-old white man, was sent to me for a routine eye examination. In 1944, people began to tell him his face was flushed at times, but he felt nothing. One year later he developed a periodic diarrhea and arthralgia. In 1949, he became dyspneic and his ankles started to swell. A face biopsy was performed in 1952 and the findings were reported compatible with lupus erythematosus. In 1954, cardiac catheterization showed tricuspid insufficiency and pulmonic stenosis. An exploratory laparotomy was done in 1955 and the patient was found to have a malignant carcinoid involving the ileum with multiple metastases to the liver and regional lymph nodes. He was placed on bromlysergic acid diethylamide and it was noted that most of the symptoms had improved perceptibly. At present he complains of feeling weak, and states that his eyesight has been failing him the last three to four years.

Examination revealed a bluish, cyanotic color of the face and conjunctivas, and the mucous membranes of the mouth and throat. There was also a moderate amount of injection in both eyes. With a correction of −1.25D. sph. ⊂ +0.75D. cyl. ax 35°, R.E., and −1.75D. sph. ⊂ +1.0D. cyl. ax. 60°, L.E., his visual acuity was 20/25-2 and 20/30-2 respectively. The fundus was grossly normal. Slitlamp examination revealed bilateral nuclear and cortical lens changes

The laboratory reported a positive 24-hour urine for qualitative 5-hydroxyindole acetic acid. The serum albumin was 2.1 gm. per 100 ml., and the serum globulin 2.6 gm. per 100 ml.

DISCUSSION

The findings in the conjunctivas no doubt are due to the vasomotor changes predicated by the pharmacologic action of serotonin. More conjectural is the cause of the cataracts. Niacin deficiency is found in altered tryptophan metabolism with hypoalbuminemia. Tryptophan deficiency produces a type of cataract in the rat.[9] The precursor of niacin may be tryptophan. Niacin is part of co-enzymes I and II, and these nucleotides are concerned with cellular respiration and the breakdown of sugar. We know too that glutathione reduces ascorbic acid. Glutathione and ascorbic acid are related to protein metabolism. The lens changes then could be due to either a toxic effect of serotonin per se, or due to an enzymatic effect and/or disturbed lens metabolism and respiration. It should be added that 5-hydroxy tryptamine (serotonin) is transposed by amine oxidase to 5-hydroxyindole acetic acid. Presence of the latter in the urine of the patient was an abnormal finding.

SUMMARY

A case of a person with the malignant carcinoid syndrome is presented. He was found to have a bluish discoloration of the conjunctivas and oral mucosa and cataractous lens changes. This is the first known instance that these findings have been reported.

733 Hinman Avenue.

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OPERATION FOR RECURRENT PTERYGIUM

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After 25 years' experience in cataract surgery and the postoperative care of 2,000 or more cases which have been followed for one to 25 years, I have not seen one case in which a pterygium developed after the operation or in which a pterygium cut by the incision was made worse thereby.

Based on these observations, 10 recurrent pterygiums, varying from one to five recurrences, were operated in the usual manner by dissecting the growth loose from the cornea, removing the thickened mass of vessels and episcleral tissue subconjunctivally, and transplanting the remaining thin layer of conjunctiva below with one mattress suture of 5-0 plain catgut, leaving a two-mm. area of clean scleral surface between the limbus and the free margin of conjunctiva.

At this stage, instead of doing one of several additional procedures advocated, a simple limbus incision was made into the anterior chamber with a narrow cataract knife, allowing this incision to extend slightly beyond the previous encroachment on the cornea both above and below. One or two 6-0 chromic radial sutures were used for closure of the wound.

All of the cases showed marked improvement after a period of three to 12 months. Seventy-five percent have shown no encroachment on the cornea and in the other 25 percent only a few small vessels have appeared on the cornea for a distance of one or two mm., either at the upper or lower part of the previous corneal involvement. These vessels remain small and do not show the usual disposition to continue growing and piling up. In only one patient of this 25 percent did a rather large number of vessels

extend onto the cornea. This case was reoperated in the same manner and, after two months, has shown no recurrence.

It is presumed that the scar tissue resulting from the healing of the wound and the section of the trophic nerve supply to the cornea, making it less favorable to vascularization, are the factors that diminish the frequency of recurrence. One might compare the incision line to the ploughed furrow used in checking prairie fires. I feel that this simple procedure will be helpful in difficult cases of recurrent pterygiums. It is offered as an additional useful procedure but not as a substitute for all other procedures.

Three of the cases reported had had prolonged beta-ray treatments by a competent, experienced radiologist. These treatments seemed to delay recurrence but did not prevent it. None of the cases received any treatment with beta rays or with the strontium applicator following the operation herein described.

209 Medical Arts Building (1).

DRY-HEAT OFFICE STERILIZATION

A PRACTICAL AND INEXPENSIVE METHOD TO STERILIZE EYE INSTRUMENTS FOR SURGERY IN A GENERAL HOSPITAL

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In 1950, while visiting Dr. H. Aruga's clinic in Barcelona, I observed a small dry-heat sterilizer. Dr. Ricardo F. Fernandez of San Juan, P.R., who was also present, stated that he and his brother had used this sterilizer in their practice for about 15 years and found it most satisfactory and that it was sold by Etablts. Rupalley, 27 Rue de Liege, Paris. I purchased one. At that time, the cost was about $25.00; it is now somewhat higher.

The instruments are placed in a metal box designed by the Department of Ophthalmology of the University of Iowa (sold by Storz) with the knives in the top rack which holds them separated. The cover is tied on the box with gauze and a Diack Sterilizer Control tube is tied to the top of the box to indicate that the sterilizer is working. The box of instruments is placed in the sterilizer for one hour and then removed with sterile technique and wrapped in a sterile towel and kept ready to take to the hospital, eliminating both the time lost in sterilizing them at the hospital and the all too frequent damage by a general surgical nurse unaccustomed to handling eye instruments.

No difficulty has been encountered in six years except that, with repeated sterilization, cataract knives, keratomes, and Ziegler knife needles lose their sharp edges. Cataract knives and keratomes can be used four or five times before resharpening. Ziegler knife needles and other less frequently used sharp instruments are therefore kept in a metal guard in a separate sterile package and not repeatedly sterilized. Scissors are not appreciably affected by this heat.

Rubber and plastic instruments are boiled or soaked and wrapped in a sterile towel in a separate package.

For convenience, three boxes of instruments are kept sterile. One contains instruments for lid and sac surgery, muscles, enucleations, detachments, and so forth. Another contains a cataract set and a third contains instruments for cataracts, glaucoma, and traumatic cases, as well as other special instruments for intraocular surgery.

A small dry-heat sterilizer sold by A. S. Aloe Company is now on the market at $32.50. While I have not used it personally, its specifications seem to indicate that it is all an ophthalmologist would require.

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THERAPEUTIC EFFICACY OF A PREDNISOLONE ALCOHOL SOLUTION

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AND
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During the brief period that the products of the adrenocortical steroids have been available, their value in the field of ophthalmology has been outstanding. The newer analogs, prednisone and prednisolone, were found by Gordon[1] to be superior to cortisone and hydrocortisone. Experimental studies on uveitis by O'Rourke, Iser, and Ryan[2] disclosed that a given anti-inflammatory response required a several times greater dosage of cortisone or hydrocortisone.

Our knowledge of the physiology and metabolism of these steroids has made possible acceptable clinical and therapeutic standards. It must be conceded, however, that the products available for topical use have had objectionable side effects. In common with other suspensions, and particularly those administered with a dropper, a uniform concentration cannot be maintained. Irritation and micro-ulcerations have been found. Deposits of crystals in the tissues, even to the extent of caking about the lid margins and fornices, have been noted. King and Wei-

TABLE 1

SOLUTION PREDNISOLONE ALCOHOL (DELTA CORTEF) 0.1 PERCENT

Case	Name	Diagnosis	Duration	Treatment (drops)	Results	Side Effects
1	Mr. E. F.	Alergic conjunctivitis (house dust)	1 mo.	t.i.d. 7 da.	Good	None
2	Mrs. H. K.	Allergic conjunctivitis (face powder)	4 da.	t.i.d. 2 da.	Good	None
3	M. A.	Allergic conjunctivitis (cause unknown)	2 da.	t.i.d. 3 da.	Good	None
4	Mrs. J. W.	Chronic blepharo conjunctivitis (cosmetics)	3 mo.	t.i.d. 3 weeks	Excellent	None
5	Miss P. C.	Allergic conjunctivitis (face powder)	4 mo.	t.i.d. 2 weeks	Excellent	None
6	Mr. A. J.	Traumatic iritis	1 da.	q. hr. 3 4 days	Excellent	None
7	Mrs. M. W. B.	Allergic conjunctivitis (mascara)	4 mo.	t.i.d. 4 days	Good	None
8	Miss A. D.	Allergic conjunctivitis	1 mo.	t.i.d. 4 days	Good	None
9	Mr. H. M.	Allergic conjunctivitis (coal dust)	6 mo.	q. hr. 3 5 days	Excellent	None
10	Mrs. L. O.	Drug reaction (Dionin) Eyes sore Itching	4 mo.	q. hr. 3 (Last seen 1 da. after starting treatment	Excellent	None
11	R. M.	Allergic conjunctivitis (cause unknown)	1 mo.	t.i.d. 3 weeks	Fair	None
12	Mrs. H. C. P.	Blepharo conjunctivitis Allergic conjunctivitis (face powder)	2 mo.	t.i.d. 1 week	Good	None
13	Mrs. O. J. S.	Allergic conjunctivitis (cause unknown)	2 mo.	t.i.d. 10 days	Good	None
14	Mr. C. A.	Blepharo conjunctivitis (tobacco smoke)	2 mo.	q. hr. 3 5 days	Good	None
15	Mrs. C. J.	Allergic conjunctivitis (Dionin)	1 mo.	q. hr. 3 10 days	Good	None
16	Mrs. T. R.	Contact dermatitis of lids (cosmetics)	6 mo.	q. hr. 4 7 days	Good	None
17	Mrs. G. R. P.	Contact dermatitis of lids (cosmetics)	3 mo.	q. hr. 4 10 days	Good	None
18	Miss C. C.	Blepharo conjunctivitis (face powder)	4 mo.	q. hr. 4 3 days	Good	None
19	Mrs. A. A.	Drug reaction (Dionin)	1 mo.	t.i.d. 10 days	Good Congestion and itching gone	None
20	Mr. R. P.	Allergic conjunctivitis (house dust)	2 mo.	q. hr. 3 8 days	Good	None
21	Mrs. G. J.	Allergic conjunctivitis (cause undetermined)	3 mo.	t.i.d. 6 days	Fair	None

TABLE 2

SOLUTION PREDNISOLONE ALCOHOL (DELTA CORTEF) 0.2 PERCENT

Case	Name	Diagnosis	Duration	Treatment (drops)	Results	Side Effects
*1	Mr. A. G.	Chronic allergic conjunctivitis (cause undetermined)	Several mo.	t.i.d. 10 da.	Fair	None
2	Mr. S. G.	Allergic conjunctivitis (road dust)	3 mo.	q. hr. 3 15 da.	Fair	None
3	Mr. R. H.	Nongranulomatous iritis	2 da.	q. hr. 3 20 da. Meticortin 5 mg. t.i.d. and mydriatics	Good results with recovery in 3 wks.	None
4	Miss R. L.	Acute allergic conjunctivitis		q. hr. 3 3 da.	Good, congestion and itching gone	Slight burning for few minutes after use
5	Mr. D. J.	Conjunctival congestion due to venous obstruction in orbit	Several da.	q. hr. 3 17 da.	Poor response No improvement	None
6	Miss M. O.	Acute nongranulomatous iritis, right & left	2 da.	q.i.d. 4 wk. (9-7-56) Cordex Forte internally 1 tablet 5 times daily (aspirin & prednisolone)	Good (Discharged 10-10-56)	None
7	Mr. C. S. G.	Drug reaction from an old Rx contents unknown	Several mo.	q. hr. 3 4 da.	Good	None
8	Mrs. W. A. Y.	Recurrent nongranulomatous iritis	2 da.	q. hr. 3 Cordex Forte tablet II t.i.d. (aspirin & prednisolone) Atropine	Good	None
9	Mrs. B. S.	Allergic blepharo-conjunctivitis Asthmatic (allergen not found)	Several yr.	Drops t.i.d. 6 days	Good Improvement	Eyes remained sore several min. after use
10	Miss R. R.	Allergic conjunctivitis (cosmetics)	Several mo.	t.i.d. 18 days	Good Improvement	None
11	Mrs. M. D.	Episcleritis (rheumatic)	4 da.	t.i.d. 2 days	Excellent	None
12	Mrs. S. M.	Allergic conjunctivitis (cause unknown) Itching & discharge	6 mo.	t.i.d. 15 days	Good Complete recovery	None
13	Mrs. M. S.	Contact dermatitis about the eyes, temples, and nose, with crust formation. (Allergen-metallic silver jewelry)	3 mo.	q. hr. 3 13 days	Good	Drops were irritating first few days only
14	Miss C. S.	Allergic conjunctivitis (cause undetermined)	Several mo.	t.i.d. 5 days	Good	None

* Better response to Neo Delta Cortef Suspension 2.5 percent.

mer,[3] in the early studies, found that, although the alcohol form of prednisone and prednisolone was more irritating than the acetate form, the effect was not particularly noticeable unless the solution was used more frequently than every two hours.

The soluble steroid preparations used in this study were supplied by the Upjohn Company, Kalamazoo, Michigan:

a. Prednisolone alcohol in 10-percent Triton solution 0.1 percent (Delta Cortef alcohol—see table 1).

b. Prednisolone alcohol in 10-percent Triton solution 0.2 percent (Delta Cortef alcohol—see table 2).

SUMMARY

Therapeutic efficiency was excellent for both the 0.1- and 0.2-percent concentrations. No difference was noted. Side effects were minimal, infrequent, and entirely subjective. They consisted of a feeling of irritation and discomfort of short duration and only in the acute stages of inflammation. In no case was it necessary to discontinue the drug. Finally, and more important, the solutions of prednisolone alcohol compared favorably in therapeutic efficacy with the suspensions and there were no corneal or conjunctival deposits and no evidence of tissue damage.

812 Black Building.

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LORGNETTE OCCLUDER FOR PRESCHOOL VISION TESTING

HENRY F. ALLEN, M.D.
Boston, Massachusetts

Although the lorgnette occluder is not new to ophthalmology, neglect of this device suggests that its advantages have been overlooked by those concerned with child vision testing.

An occluder* such as that pictured in Figure 1, when used in testing the vision of preschool children, permits substitution of the appealing request, "Look through the hole in the fence," for the forbidding one, "Cover up one eye." In private practice and in the Orthoptic Clinic of the Massachusetts Eye and Ear Infirmary, it has been found that this positive approach secures greater cooperation from young patients and reduces their tendency to peek around the cover. The assistance of an adult in steadying the occluder is often helpful.

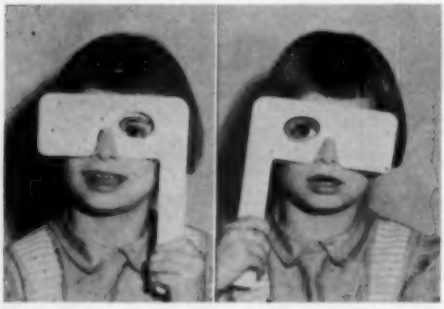


Fig. 1 (Allen). Lorgnette occluder for preschool vision testing.

The occluder is also useful in adult vision testing and can be used over spectacles.

200 Beacon Street (16).

* Manufactured by Ophthalmix, Inc., La Grange, Illinois.

ECTOPIA OF THE MACULA*

PHILIP P. ELLIS, M.D.
Iowa City, Iowa

Ectopia of the macula is described as a distinct clinical entity which is characterized by the appearance of a pseudostrabismus occurring as a result of an exaggerated disparity between the visual and optic axes. The macula does not occupy its customary position which is 1.5 mm. temporal to the optic axis; hence the visual axis is along a significantly different line. If the macula is displaced up or down from its normal position, then a vertical pseudostrabismus is present; if the displacement is in or out, then a pseudohorizontal strabismus exists.

There have appeared three separate reports of ectopia of the macula in the English literature in the past year.[1-3] Prior to this time there were only 14 reported cases, and two of these have been questioned by Horowitz as representing true ectopia of the macula.[1] The following cases are reported because the condition appeared in siblings. Triebenstein[4] reported a mother and son who had ectopia of the macula; there was a similarity of fundus lesions in the two, though macular displacement was somewhat different.

CASE REPORTS

CASE 1 (brother, aged four and one-half years)

The parents first noticed that the left eye turned out at the age of 18 months. The child was seen by an oculist who prescribed glasses and patching of the left eye at the age of two and one-half years. The patient refused to wear his patch. There had been no improvement in the position of the eye. In a review of the history it was learned the child was about two weeks premature; birth weight was six pounds, three ounces. He did not receive any oxygen.

On examination it was found that the vision in the right eye was 4/60 (illiterate E) and 6/8 in the

* From the Department of Ophthalmology, College of Medicine, State University of Iowa.



Fig. 1 (Ellis). Brother. Apparent left exotropia. Left eye fixating.

left eye. On Hirschberg examination the child appeared to have about 15 degrees of left exotropia (fig. 1). The fixation appeared to be eccentric in the left eye. Orthoptic evaluation revealed that there was a small eso shift on prism and cover test. There was suppression of the right eye on the Worth four-dot test. The rotations were normal.

A cycloplegic refraction revealed the following error: O.D., +0.25D. sph. ⊃ +1.75D. cyl. ax. 100°; O.S., +0.25D. sph. ⊃ +0.75D. cyl. ax. 150°.

Ophthalmoscopic examination of the right eye showed the presence of bands in the retina radiating out from the temporal portion of the disc (fig. 2). They involved the macular area and were quite dense in the area just below where the normal anatomic position of the fovea would be. No foveal reflex was observed. In the region of the equator in the inferior temporal quadrant there was a large area of depigmentation, retinal and choroidal atrophy. The vessels assumed a sinus inversus pattern as they came from the disc.

The left eye showed a few fine folds radiating from the temporal side of the disc, about one disc diameter in size (fig. 3). A good foveal reflex was seen in approximately the normal vertical position but appeared more temporal than nasal. In the equatorial region of the inferior temporal quadrant a few small round areas of pigmentation were noted.



Fig. 2 (Ellis). Brother. Sketch of the fundus of the right eye. Bands radiating out from the disc involve the macular area.

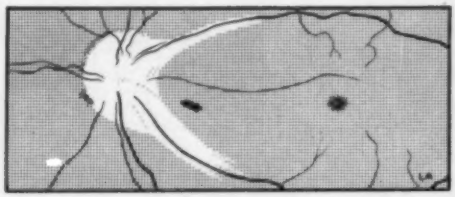


Fig. 3 (Ellis). Sketch of fundus of the left eye. Fine bands radiating from the disc. Macula displaced temporally.

CASE 2 (sister, aged three years)

The parents first noticed the right eye began to turn in at the age of about 12 months. The child was seen by an oculist at the age of 18 months but he did not prescribe any treatment. This child was about four weeks' premature. The birth weight was five pounds, two ounces. No oxygen had been received.

On examination it was found that the vision in the right eye was 2/60 (illiterate E) and 6/15 in the left eye. By Hirschberg test the child had about 10 to 15 degrees of right esotropia and about 10 degrees of right hypertropia (fig. 4). There was eccentric fixation in the right eye. There appeared to be an eccentric fixation in the left eye which was described as a positive angle kappa. The rotations were normal except for an overaction of the right inferior oblique.

A cycloplegic refraction revealed the following error: O.D., +0.25D. sph. ⊃ +1.75D. cyl. ax. 100°; O.S., +0.25D. sph. ⊃ +0.75D. cyl. ax. 150°.

Ophthalmoscopic examination in the right eye showed presence of fairly dense retinal lines radiating out from the disc toward the macular area and down into the outer temporal quadrant (fig. 5). There were some pigmentary changes in the macular area. No foveal reflex was present but on instructing the child to look at the light she would fixate in an area below the normal position of the fovea. This area was nasal and below the normal position of the macula.

The left eye showed a few faint folds radiating out temporally from the nerve, about one disc diameter. There was a good foveal reflex which



Fig. 4 (Ellis). Sister. Apparent right esotropia and right hypertropia.



Fig. 5 (Ellis). Sister. Sketch of the fundus of the right eye. Macula (X) displaced nasal and inferior to normal position.

appeared in the normal position. No pigmentary changes were seen.

Two other siblings, aged two years and 10 months, did not show any ocular disease. Likewise the mother and father did not have any eye disease.

Comment

From the reported cases in the literature, one gathers that the displacement of the macula is the result of traction bands formed in the retina. These bands may develop as a result of chorioretinitis, phlebitis, retinal hemorrhages that have absorbed, trauma, and possibly also diathermy for retinal separation. Payne and Creek[3] also mention the possibility of aborted retrolental fibroplasia. Since both of these children were somewhat premature, it is possible that a very mild stage of retrolental fibroplasia was responsible. However, the older patient showed peripheral areas of old chorioretinitis, suggesting an intrauterine inflammation.

The possibility of a developmental anomaly should also be considered. Although the appearance of these retinal bands is not identical with the usual clinical picture of congenital retinal folds, there is enough similarity to suggest a common etiology. The theories of both Mann[5] and Weve,[6] namely adhesions of the primary vitreous, are plausible in explaining the development of retinal bands causing ectopia of the macula. Such adhesions of course, as pointed out by Horowitz in citing Barber, would develop long before the inner portion of the optic cup differentiates to form the macula. Therefore, in such a hypothesis, one would be led to believe that the adhesions causing retinal bands would not prevent normal retinal differentiation from occurring. Van Wien and Sullivan[7] in describing the histologic appearance of a case of congenital retinal fold noted that retinal elements were poorly differentiated.

Some interesting points are raised in the study of ectopia of the macula in relation to the etiology of pseudostrabismus. The size of the angle kappa is dependent upon the position of the fovea.[8,9] It is known that in hyperopia the angle kappa is usually positive and that in myopia the angle is frequently negative. In emmetropia the angle is usually about five degrees positive. The correlation of the refractive error and the angle kappa is understandable; the larger the anteroposterior axis the closer the fovea is to the optic axis.

The questions then arise:

When is a fovea ectopic?

Is the presence of visible bands of the retina with gross displacement of the fovea necessary to make a diagnosis of ectopic maculae?

If the angle kappa is exaggerated—10 to 15 degrees—and there are no visible bands and no significant refractive error present, can a diagnosis of ectopic maculae be made?

Is evidence of mechanical displacement necessary?

Certainly the answer is still unknown. Heretofore, the term ectopia of the macula has been reserved for a pseudostrabismus that resulted from mechanical displacement of the fovea. The cases reported are similar to those previously described.

University Hospitals.

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Ophthalmic Miniatures

I beg to state that these small opacities undoubtedly are at the point of attachment of the hyaline artery to the posterior capsule of the lens and that during the disappearance of the artery the mutation of this part of the capsule is sufficiently interfered with to lead to the cloudiness of this point, or that slight inflammatory changes during the process of absorption exist.

W. F. Mittendorf, 1892,

"On the frequency of posterior capsular opacities at the place of attachment of the hyaloid artery,"

Transactions, American Society Ophthalmology, **6**:412, 1892.

(And so immortality! Ed.)

* * *

In 1878, Stabarzt Dr. Sellerbeck successfully transplanted a flap from a child's cornea into a badly scarred adult cornea. In his publication (Archiv für Ophthalmologie, **24**/4:45) he complained that, without his consent, the newspapers reported about his operation, using unwarranted exaggerations, including—as nowadays—the substitution of totum pro parte; that is, changing the transplantation procedure of part of the cornea into replacement of a blind eye by a seeing one. (Nihil novi sub sole.)

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

April 13, 1956

DR. BERNARD KRONENBERG, *President*

ROUND TABLE CONFERENCE: EXOPHTHALMOS

Discussors: DR. JOHN W. HENDERSON, DR. HOWARD C. NAFFZIGER, DR. SOLOMON SILVER, AND DR. EDMUND B. SPAETH.

Moderator: DR. BERNARD KRONENBERG

1. *Is there justification for a division of progressive exophthalmos into thyrotoxic and thyrotropic types?*

DR. HENDERSON said that when the comprehensive article of Mulvaney appeared in 1944, a complete and logical basis for the division of exophthalmos into thyrotoxic and thyrotropic types appeared to be established. However, it soon became apparent in following patients with exophthalmos that such a clear-cut distinction was not always possible. While a patient might demonstrate the pure signs of thyrotoxicosis, there would also be an associated progression of thyrotropic findings. Although Mulvaney stressed the relief of myasthenic weakness of the extraocular muscles following treatment of thyrotoxicosis, reports appeared, such as that of Dobyns, in which the eyes of all but nine of 233 consecutive thyroidectomy patients increased in prominence after surgery, and significantly so in over 50 percent.

The majority of these patients showed gross improvement regardless of the actual increasing proptosis, and the greater the fall in basal metabolism rate the greater was the increase in measurement. Dobyns was also able to collect 129 patients from the literature where loss of vision or of the eye had occurred during severe thyrotoxicosis.

Mulvaney's thyrotropic group, in which released thyrotropic activity after thyroidectomy produced orbital changes, has been widely documented and studied. However, reports of failure of thyroid administration to inhibit uniformly thyrotropin (TSH) production, together with a failure to demonstrate increased thyrotropin production in all cases of progressive exophthalmos during an active phase, have raised other doubts.

Cordes separates exophthalmos cases into progressive and nonprogressive, since, in his opinion, ocular changes that occur in thyrotoxicosis should not be confused with the progressive disease referred to as "thyrotropic exophthalmos." He further feels that blood thyrotropin levels would aid in the distinction. Unfortunately, a simple and reliable method for such a determination is not readily available.

Falconer and Alexander pointed out that although all of their patients who developed malignant exophthalmos after thyroidectomy showed an excess of blood thyrotropin, so also do most patients after medical or surgical therapy for toxic goiter. Purves and Griesbach found that nine of 37 sera tested for thyrotropin in malignant exophthalmos did not show elevation, even in the progressive phase. They felt also that in most individuals the presence of excess thyrotropin in the blood does not lead to malignant exophthalmos, and suggested a correlation between the two but no direct causal relationship.

Recent work by Dobyns using the Atlantic minnow, Fundulus, suggests a further potent pituitary hormone EPS which is not the same substance as thyrotropin, and which can be demonstrated in the blood serum of patients suffering with severe or progressive exophthalmos. A correlation was suggested between the degree of exophthalmic response in the fish and the stage and severity of the patient's exophthalmos.

The current view may be stated that severe progressive exophthalmos appears in three clinical states:

1. As a part of Graves' disease in addition to the thyrotoxic signs.

2. More often after thyroidectomy when the picture of thyrotoxicosis has been ameliorated.

3. In patients without goiter or preceding thyrotoxicosis.

Dobyns believes that these are all basically the same phenomenon, and can occur in all degrees from slight increase in prominence of the eyes to severe proptosis. If the course is rapid, orbital congestion does not allow adaptation and severe ocular changes may occur. If the course is slower, there may be gradual compensation without serious ocular damage, but the longer the process lasts the more irreversible it becomes. The process may be self-limiting, and when the driving force behind the disease abates, exophthalmos may regress or remain fixed, with return of as much extraocular muscle function as reversibility may permit.

Falconer and Alexander also believe that their findings tended to refute Mulvaney's idea of two distinct types of exophthalmos, favoring the view that the condition is a single entity. By examining their pathologic specimens of involved muscle and reviewing Mulvaney's differential on a pathologic basis, they agreed that findings suggested a common histologic process which varies in intensity and degree between individual patients. They concluded that malignant exophthalmos is a single pathologic entity which can occur either in association with or independently of enlargement of the thyroid and thyrotoxicosis.

Hedges and Rose state that the hyperophthalmopathic syndrome may be regarded best as a clinical spectrum, ranging from simple proptosis and lid retraction to the most severely progressive form with congestive phenomena and visual loss. They could not justify the division of the syndrome into the so-called thyrotropic and thyrotoxic forms, in spite of the undoubted occurrence of wide clinical variation.

Aside from the lid retraction, staring expression, lid lag, and many other signs of thyrotoxicosis per se, all other signs appear due to congestion within the orbit and extraocular muscles.

In view of the findings and opinions reviewed, it appears that it is not justified at the present time to divide progressive exophthalmos into thyrotropic and thyrotoxic types, but that progressive exophthalmos may occur with or without added signs of thyrotoxicosis.

DR. SILVER agreed that so little is known basically about the mechanism in either of these cases that it seems presumptuous to try to delineate them into two groups. It is thought that one form is due to the presence of excessive thyroid hormone for which there is no evidence at all, and the second due to an excessive thyrotropin, but there is little evidence for that. It is best not to use these terms but to use general terms as a reminder that the answer to this problem is not known.

DR. NAFFZIGER commented that he thinks there is no difference whatsoever in the pathologic process in a thyrotoxic and thyrotropic group except one of degree.

2. *What is the relation between the duration of exophthalmos before thyroidectomy and progressive exophthalmos?*

DR. NAFFZIGER replied that only cases sufficiently severe to require operation were analyzed. In the great majority of cases the exophthalmos had been present before thyroidectomy but there was no evidence that its duration prior to thyroidectomy bore any relation to later progression.

DR. KRONENBERG asked whether the exophthalmos became worse after the thyroidectomy.

DR. NAFFZIGER said yes, in a considerable number of cases. In an ordinary exophthalmic goiter, it was found that 40 percent of patients, although they may look better and lose their stare, actually have an exophthal-

mos which measures more after operation than it did before. There is no relation between the length of time exophthalmos existed before thyroidectomy and later progression.

DR. SILVER commented that, in his experience, once progressive malignant exophthalmos starts it runs a very rapid course.

3. *What is the relation between ocular signs and the clinical course of hyperthyroidism?*

DR. SILVER said it is interesting because there is no known area in clinical medicine in which a symptom which is an intrinsic part of a disease complex runs a course which seems to be completely independent of the basic disease. True exophthalmos is almost limited to hyperthyroidism. A little is seen in uremia, encephalitis, and so forth. Patients with the severest grades of hyperthyroidism die, never having shown a single sign in the eye. Patients are seen in whom it is difficult to make a diagnosis of hyperthyroidism. There are patients with unilateral or bilateral exophthalmos, to all intents identical with that found in Graves' disease, who never develop hyperthyroidism.

Patients with normal eyes who have the disease in a severe form recover by one means or another. He reported a patient with normal eyes who had active hyperthyroidism and remained in myxedema for eight years and who now has rapidly progressive bilateral infiltrative disease of the eyes. If a pattern can be formed then a keener insight into the disease can be gained.

What happens to the eye is unpredictable and there is little that can be done to make much difference about what happens to the eyes. Eyes may get better when the general condition gets worse and vice versa.

No matter how strictly hyperthyroidism is controlled, patients are for the most part very unhappy if left with exophthalmos. The only thing Dr. Silver could say is that, although he is convinced that these things are related, he does not understand how. The clinical course of the systemic disease of hyperthyroidism does not determine the clinical results so far as the eyes are concerned.

DR. HENDERSON asked Dr. Silver why he calls it thyroid disease at all.

DR. SILVER replied that it would seem very unlikely that of 100 patients with exophthalmos 99 of whom have demonstrable thyroid disease, the remaining one case should develop from an entirely different cause.

4. *What is the etiologic difference between bilateral and unilateral exophthalmos?*

DR. SPAETH said that usually it is a permissible generalization to relate bilateral exophthalmos either to thyroid dysfunction, eosinophilic granuloma, or to some manifestation of the Schüller-Christian syndrome complex, to hydrocephalus, and to those rather rare cases of congenital craniostenosis or other bony facial deformities. It is probable that thyroid dysfunction is the most common of all of these causes.

Bilateral exophthalmos in children is especially important. Recently McClintock, Frawley, and Holden presented a study of 50 children, ranging from two to 15 years of age, with a confirmed diagnosis of thyrotoxicosis. Of the eye disturbance in these children, the most frequently noted was bilateral exophthalmos. Another interesting comment by these observers was that the exophthalmos was generally reversible through treatment.

Unilateral exophthalmos is an entirely different sign. It is an ocular manifestation of a local orbital pathologic process, traumatic, hemorrhagic, suppurative, inflammatory, and/or from an intraorbital space-taking lesion, or an ocular manifestation of such an intracranial pathologic alteration as, for example, sinus thrombosis, arteriovenous fistula, intracranial aneurysm, sphenoidal ridge meningioma; or it may be an accompaniment of a pathologic alteration in the pituitary.

One further warning, do not consider dis-

similar bilateral exophthalmos as a unilateral condition. This has occurred in the past and will occur again in the future.

DR. NAFFZIGER said that oftentimes it is difficult to tell whether a person has bilateral exophthalmos or not. The normal exophthalmometer measurements for a given person are not known. If findings 1.0 or 2.0 mm. above the normal average are present, doctors do not know whether they are dealing with bilateral exophthalmos or not. In his judgment as to whether there is bilateral exophthalmos or not, the doctor often has to rely upon the measurements of retrobulbar pressure. The degree of exophthalmometer reading is the important thing.

DR. SILVER commented that unilateral exophthalmos should make one think of a local lesion, and bilateral of a systemic disease. He cited a case of benign adenoma of the thyroid that developed unilateral right exophthalmos and was observed carefully. It is now perhaps three years since this patient was watched and there is no question but that she has a meningioma of the sphenoidal ridge. Dr. Silver said he had been aware of the possibility but could not establish it.

5. *Discuss the diagnosis of optic nerve tumors. What is your approach in treatment?*

DR. HENDERSON said the glioma is the major tumor of the optic nerve which he would like to discuss. Gliomas are usually diagnosed by their occurrence in the first decade of life; 85 to 90 percent of such tumors occur within the first two decades. The association of gliomas of the optic nerve with neurofibromatosis has been shown repeatedly, although in younger children the associated changes are less likely except for cafe-au-lait pigmentation. Profound visual loss occurs and may be present for months to years before exophthalmos develops. There may be primary optic atrophy or in some cases extreme papilledema when the tumor interferes with the circulation.

As proptosis develops it is straight forward and without extraocular muscle paralysis. If the tumor is intracranial, there may be long periods with nothing suggesting tumors except loss of vision and optic atrophy. Extension into the chiasm may produce temporal field loss in the opposite eye. Direct chiasmal involvement may be manifested by bitemporal field defects, optic atrophy, vertical nystagmus, diabetes insipidus, obesity, and hypogenitalism.

Special orbital projections on X-ray examination may reveal enlargement of the optic foramen on the involved side. Walsh states that enlargement of an optic canal as an isolated finding is not as important as is lesser enlargement associated with loss of vision and optic atrophy. Erosion of the bone of the canal is not essential to the diagnosis of optic-nerve tumor because in some instances the canal has been enlarged but not visibly eroded when a glioma has been removed at operation.

At Dr. Henderson's clinic, suspected tumors of the optic nerve are investigated by a transconjunctival approach if the optic foramen is not enlarged. By this approach the optic nerve can be palpated and a spindle-shaped enlargement noted. This is removed by clamping the nerve with a large curved tonsil hemostat with open rings so that after the nerve has been severed with scissors the wire of a tonsil snare can be slipped over the hemostat and optic-nerve tumor and the nerve can be severed deep in the apex of the orbit. The posterior extremity of the specimen is tagged and studied for the presence of tumor. If involvement appears to extend into the optic canal, a neurosurgical approach is then considered after a suitable postoperative period.

When there is enlargement of the optic foramen or fields show chiasmal involvement, transcranial removal by the neurosurgeon is primarily indicated.

In view of the recent article by Love, Dodge, and Bair advocating a primary intracranial approach for removal of these lesions, Dr. Henderson wondered whether he is right in his views. These authors placed no

special emphasis on X-ray findings in the four patients reported. In one, a normal skull was reported; in another, normal views were obtained; and in the other two cases no X rays were mentioned. In all four cases the tumors were found to extend into or beyond the optic canal.

DR. NAFFZIGER commented that in a slide Dr. Henderson showed of a boy with a tumor of the right orbit, the lid was not retracted. It came down over the cornea. That is more characteristic of orbital retrobulbar tumors than it is of hyperthyroid cases. Another point is that Dr. Silver mentioned the sphenoid ridge meningiomas. These are very rare in men. He did not take any exception to what Dr. Henderson had to say about the optic nerve tumors.

DR. SPAETH said that he had seen X-ray changes or X-ray deformity of the optic foramen in many instances in which the transfrontal opening of the orbit failed to confirm the necessity for this approach. He was inclined to doubt the value of X-ray findings as sufficient indication for a transfrontal uncapping of the orbit. A normal surgical external orbitotomy is done in all instances unless there are signs and symptoms other than the X-ray findings of the optic foramen which indicate extension of the lesion out of the orbit, or entrance of the lesion from an intracranial source into the orbit.

6. What do you consider the indications for orbital decompression? Is limitation of eye movements an indication for decompression?

DR. NAFFZIGER said that it can be summed up by loss of vision or threatened loss of vision. Out of 38 cases, seven had corneal ulceration, one abnormal visual fields, two the lower half of the fields was lost; others showed choked discs, slight blurring of the optic discs, edema and protrusion, abnormal pupils, and so forth. Most common is diminution of vision without any findings to account for it. This is presumably due to retrobulbar tension upon the optic nerve and circulatory alterations in it. When tension is relieved, vision comes back at once. He added that in one recent case, in which it was not believed vision was threatened, he operated for cosmetic reasons. The patient had a striking exophthalmos. She was an actress and by reason of her appearance she was unemployable. Dr. Naffziger did a bilateral decompression. He does not consider limitation of eye movements an indication for decompression.

DR. SILVER asked whether Dr. Naffziger often had difficulties with binocular vision after a bilateral decompression. DR. NAFFZIGER replied the condition is rare and did not appear unless it existed before.

7. What medical treatment can be depended upon to relieve exophthalmos, including the progressive types?

DR. SILVER said that the medical treatments are almost without limit. It is a good general rule that, if one has many treatments for a specific symptom, the chances are he has none. If anyone could bring forth a reliable consistent treatment for exophthalmos, it would be the answer to this question. He remarked that he sees many of these patients, and is of the belief that these people are entitled to anything that can be done, without doing them harm. At one time or another he has gone through the whole gamut of suggested treatments for exophthalmos.

For the medical treatments there are thyroid extract, iodines, hormones, use of ACTH, and cortisone. He is not prepared to state at this time that he is convinced that any one form of medical treatment significantly alters the course of exophthalmos. All of these patients who are not actively hyperthyroid are given thyroid extract. How much good it does he is not prepared to state.

DR. NAFFZIGER commented that he agreed completely. The tolerance to thyroid extract is almost unpredictable. He has seen some patients tolerate thyroid substance in doses of

eight or 10 gm. per day with no symptoms at all. He is not sure, however, that this phenomenon is peculiar to patients with exophthalmos. Thyroid substance was emphasized deliberately to see whether the exophthalmos could be halted. There was no effect on the eyes.

8. *What is the earliest ocular muscle sign to suggest thyroid dysfunction?*

Dr. Spaeth said that Dr. Naffziger mentioned a case of unilateral exophthalmos in which the eye was lost and, subsequent to this, exophthalmos occurred in the opposite eye from thyroid dysfunction. In one instance a high degree of unilateral exophthalmos was treated with massive X-ray therapy, no other reason being given than that the ophthalmologist and the roentgenologist knew of nothing else to do. This eye was lost by perforation of the cornea and phthisis bulbi. A year and a half later exophthalmos occurred in the remaining eye, and at that time a correct etiologic diagnosis was made.

A convergence insufficiency is probably the earliest occular muscle sign suggesting thyroid dysfunction. This may appear in cases without a significant amount of exophthalmos. It is probably as common in the low degree cases of toxic thyroid dysfunction as in those with a thyrotropic type of dysfunction. Recently, at the Bedell lecture in Philadelphia, given by Dr. A. D. Ruedemann, the importance of this observation was emphasized.

9. *What is your experience with pituitary irradiation in the treatment of exophthalmos?*

Dr. Henderson said that experience with pituitary irradiation in treatment has been mainly that of Beierwaltes at his hospital, and patients so treated have been followed closely. Twenty-eight patients with malignant exophthalmos were treated with X-rays directed to the region of the pituitary gland, and 13 of these showed a significant response in exophthalmometer measurements after treatment. Eleven of the patients began to respond in less than seven months, and maximum recession reached a median of 3.0 to 4.0 mm. during the 19-month average follow-up procedure. He suggested also that response occurs only if the exophthalmos has been present less than one year.

A point made by Beierwaltes, and often overlooked, is that the size of X-ray ports overlapped some retrobulbar soft tissue. The type of acute change in the orbit in the congestive phase of progression might well be expected to respond to irradiation. Other workers have not uniformly reported the size of ports, but in some this has been done.

Beierwaltes believes that the X rays act primarily on the retrobulbar tissue rather than the pituitary. He followed the follicle stimulating hormone levels serially in four patients and found no change after irradiation. He believes that not over 20 percent of the candidates respond favorably when irradiated after a progressive exophthalmos of 18 months' duration.

Arnold has shown that the hypophysis is resistant to high doses of X irradiation, and demonstrated in monkeys that the hypothalamus shows changes in the paraventricular and supraoptic nuclei when X rays are directed to the pituitary region. He also stated that the delayed intervals before change after irradiation observed by Beierwaltes in his clinical study conformed strikingly with the time intervals found for hypothalamic nuclear change in his experiments. More recently, Ganong, Fredrickson, and Hume have shown in the dog that selective lesions of the anterior median eminence of the hypothalamus produce thyroid atrophy.

Therefore, it is not certain at present whether the results observed clinically are due to pituitary change, hypothalamic alteration, or effects on the retrobulbar tissue. Further, the tendency of progressive exophthalmos to run a self-limiting course in many cases raises other questions.

At the present time, Beierwaltes believes that hyperthyroidism should be treated first,

if present, preferably with radioactive iodine. If no improvement or increase of eye signs occurs, desiccated thyroid should be tried for a few months; and if no improvement or progression occurs, pituitary and retro-orbital irradiation should be done. If, after six months, the patient is worse, or stationary with a high measurement endangering the eyes, decompression is indicated.

DR. SPAETH said that he has discontinued pituitary irradiation entirely. He doubts whether X-ray treatment of the pituitary has any relationship or value in the treatment of exophthalmos from thyroid dysfunction.

DR. SILVER commented that his experience has not been extensive but it has not been encouraging and for the most part it was discontinued since he did not see any improvement from it. If a case is treated early good results from other forms of therapy can be obtained. Not too much is known about the spontaneous course of this disease. Early cases will often do well with time alone.

DR. NAFFZIGER commented that he had used this treatment in about 13 cases. It was purely pituitary irradiation and did not include the retrobulbar tissues. Nothing was obtained from it at all. Most of the literature leaves doubt as to whether pituitary or retrobulbar tissues are being discussed. He agreed that nothing is known about the course of the disease. Serious visual loss is the real indication for operation.

10. *Discuss the management of cases with marked edema and protrusion of the mucosa before and after decompression.*

DR. NAFFZIGER said that he would like to know how to treat those cases in which there is marked protrusion of the conjunctiva. That is one of the sorest trials that exists. The most important thing is prevention. Postoperative edema is a trial and increases hospital stay. In prevention, he said that before orbital surgery is done it is desirable to suture the lids together for five to seven days and maintain light compression over the lids in the postoperative period.

11. *What is the mechanism of exophthalmos in man? Do the sympathetics play any role?*

DR. SILVER said that he thinks it is difficult for one to attribute a predominant role to the sympathetics in man. He could not answer categorically whether it plays a significant role in the exophthalmos.

What is the mechanism of exopathalmos in man? There is an increase in volume ultimately. In the early stages the first change is an accumulation of glycoproteins and an inhibition of water. In the later stages there are numerous changes in the extraocular muscles, accumulations of fat, appearance of fluid, all of which must push the eye forward. He does not know the basic underlying physiologic disturbance that accounts for this whole process. He does not think that thyroxin plays a great role, nor is he sure of the role of the pituitary.

12. *What is the value of X-ray studies in the differential diagnosis of intraorbital lesions?*

DR. SPAETH said that X-ray studies are probably one of the most important diagnostic procedures. About 15 years ago, the mother of a young ophthalmologist was referred to him for orbitotomy. The case had been carefully studied, with a diagnosis of intraorbital neoplasm. The X-ray films showed undoubted evidence of a mucocele. A few days ago a patient was referred who had been under observation by an ophthalmologist for four years for unilateral exophthalmos. In the letter of transmittal the statement was made: "The exophthalmos was more marked on the left than on the right and was considered to be a form of thyroid dysfunction." The X-ray signs were classical for sphenoidal ridge meningioma. X-ray studies taken two or three years earlier would have made possible earlier surgery with a longer life expectancy, and would have prevented the optic atrophy present. These are two extreme examples.

Even mixed cell tumor of the lacrimal

gland shows significant bone density changes. Optic foramen deformities, gross dissimilarities in the pattern of the frontal sinuses, bone density disturbances, even actual destruction of the bone, are all easily demonstrated. The so-called soft tissue technique will frequently show evidence of a sharply circumscribed isolated lesion, as a neurofibroma, a hemangioma or a sarcoma. In general, careful X-ray studies are of inestimable help in differential diagnosis, positive as well as negative findings.

13. *Discuss the diagnosis and management of orbital lymphomas.*

Dr. Henderson said that lymphomatous tumors may be localized entirely at one site or at multiple sites. They may or may not involve the blood stream at the same time or later. The tumor is known to change from one degree of malignancy to another and thus the prognosis is difficult to state until late in the disease. With this tendency to change the cell type and thus the degree of malignancy, repeated biopsies over the years along with repeated differential blood counts and, on occasion, bone marrow biopsy to rule out leukemic changes, is indicated.

Subconjunctival lymphoblastoma may be a primary condition and the only manifestation to be found, as in the case cited by Dr. Henderson. At no time before or in the 10 years the patient has been followed since therapy has there been evidence of general disease. The lesions are salmon-pink, smooth, without vessel dilatation, and tend to take on the contour of the tissues involved. A pseudoptosis may occur due to thickening and weight of the upper lid when it is involved. These lesions disappear promptly with irradiation and rarely recur.

Schulz and Heath reported that less than one percent of a total of 1,671 ocular tumors were lymphomas primary in the region of the eye—pointing out their rarity. This small percentage may perhaps be explained by the absence of true lymphatics in the orbit, although lymphoid tissue is encountered subconjunctivally and in the lacrimal gland. McGavic collected a series of 21 lymphomatous tumors with ocular manifestations, and 14 of these eventually were determined to be primary in the region of the eye. Seven of the 21 were in the lacrimal gland, five were subconjunctival, five in the lids, three in the orbit, and one in the iris. Of the 14 primaries seven remained localized and seven spread later.

Lymphomatous tumors presenting in the orbit or subconjunctiva seem to point to a relatively good prognosis, with prompt X-ray therapy, so long as signs of remote disease are not already evident. With remote disease evident concomitantly these cases usually succumb promptly despite treatment.

Lacrimal gland involvement occurred in three cases. In one, there was recurrence in the other gland as well as repeated subcutaneous nodules over a period of years from the first manifestation. All three lacrimal gland involvements responded completely with irradiation. No evidence of systemic disease was ever found in any of these cases. When the lacrimal gland is involved it presents as a smooth mass deep in the tissues and presents more on the conjunctival than the skin side of the tumor. This may be of help in differentiating from mixed lacrimal gland tumor.

Orbital involvement by lymphoblastoma is best treated by irradiation. If a mass is accessible for biopsy, this should be done first. When all other studies fail to point to an etiologic factor, it has been Dr. Henderson's custom to employ a diagnostic course of irradiation in order to rule out lymphoma before more definitive surgery. This dates from an experience in his department many years ago when a frozen section indicated sarcoma of the small round-cell type. Exenteration was done, only to have the control sections report lymphoblastoma the following day.

Evidence shows that in the lymphomas, long survival is dependent largely on the disease being treated either surgically, followed

by irradiation, or by irradiation alone while the disease is still localized. McGavic has recently pointed out that the prognosis in lymphomatoid disease about the eye is not as poor as is generally believed.

14. *What is your present surgical procedure to relieve progressive exophthalmos, and what are the mortality and morbidity rates in extensive orbital decompression?*

Dr. Naffziger said that in his first six cases in which the orbit was decompressed by the intracranial route, he removed the floor of the anterior fossa only. The sixth case ultimately required enucleation of one eye as the recession was inadequate. In more recent cases the entire roof of the orbit and its posterolateral wall, the pterion, and the greater sphenoidal wing are removed. The amount of recession on the eye is not very great. Ultimately the exophthalmometer readings average about 4.0 mm. below the preoperative measurements but the amount of recession is not the significant factor. The important thing is that the retrobulbar pressure that is pushing the eye forward is reduced and stays down.

As to the mortality and morbidity: one eye was lost, as noted above. There have been no deaths. The most common complication is a lasting protrusion of conjunctiva. This subsides in days or a few weeks.

Dr. Kronenberg asked how many decompressions Dr. Naffziger had performed.

Dr. Naffziger replied about 60. He did not operate on eyes that were prominent and progressive only, but exclusively on those with loss of vision, with the one exception that he had mentioned previously, the case in which the patient was prominent in the theatrical world.

15. *What are the medical indications and contraindications for surgery in exophthalmos?*

Dr. Silver replied that he would say in general no surgical procedure should be carried out on an actively toxic patient. He agreed that decompression is an operation indicated only for the preservation of sight. Ulcerative corneal lesions and protective procedures such as lid sutures can be extremely valuable and safe but, if one has to close the lids in hyperthyroidism, he cautioned that there should be no tension on the lids.

16. *Describe your approach to the problem of orbital decompression.*

Dr. Henderson replied that indications for decompression have been covered thoroughly. Until recently all decompressions have been done by the Department of Neurosurgery by the Naffziger approach. The temporal decompression of Guyton or the Shugrue external orbitotomy as presented by Moran has not been used. Recently, the members of the Neurosurgery Department have been trying a different approach to decompression. They successfully effect decompression of the orbit through a temporal craniectomy, excising the sphenoidal fissure down to the orbital fissure and then removing the anteromedial orbital roof and entire lateral wall of the orbit.

17. *Discuss the problem of increased ocular tension in thyrotoxic and thyrotropic exophthalmos.*

Dr. Spaeth said that increased intraocular pressure is a factor in all studies of thyroid dysfunction when accompanied by extensive or long-continued intraorbital disturbances. The endocrine storm responsible for the intraorbital changes probably causes disturbances in the venous drainage of the globe and, in consequence, aqueous outflow is impaired. Results from surgery in these cases are poor. It is possible that disturbances in the venous circulation of the bulbar vortex veins is the reason for the poor surgical results. The medical treatment for this type of hypertension with steroid therapy and Diamox seems to be much more promising than the surgical treatment of this type of secondary glaucoma.

Jesse M. Levitt,
Recording Secretary.

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EXPERIMENTAL OPHTHALMOLOGY: I

The past 10 years have seen an unprecedented growth in medical research, particularly that involving the adaptation of the techniques of the physical sciences to medicine. Research, too, has acquired a respectability and appreciation on the part of the physicians and the public. No longer (or at least not as much as before) is the investigator regarded as an eccentric introvert, withdrawn and uninterested in the surrounding world and its "real" problems, and content to survive, together with his equally undemanding family, on crusts and scraps provided by practical and hard-headed colleagues. Rather his important contributions to medical practice are recognized and ap-

preciated, he plays an ever more important role in clinical medicine, and, although the majority of his practicing colleagues do not envy him, neither do they pity him.

With the emergence of medical research, there has been increasing discussion of the methods, the nature of the support required, and results to be derived from investigation. The most important and extensive report, *Medical Research: A Midcentury Survey* (Little Brown and Company, Boston, 1955), was reviewed in these columns last year (Am. J. Ophth., **42**:155, 1956). The investigators themselves have developed a refreshing candor concerning the mechanics of research and increasing numbers each year describe the philosophy, motivations, mechanics, and rewards of experimental studies. For the ophthalmologist, Alan C. Woods' perceptive essay (Am. J. Ophth., **39**:29 (Apr., Pt. II), 1955), read on the occasion of the dedication of the Proctor Laboratories, indicates the beginnings, the present position, and the future possibilities of ophthalmic research.

The financial support of medical research has been widely discussed (Science, **124**: 1185, 1956; American Scientist, **45**:150, 1957) and even the psychology and socioeconomic dilemmas of the scientist (Am. Scientist, **41**:596, 1953, and **42**:104, 1954) have received attention. Quite evidently research has acquired a respectability, an unprecedented importance, and the men of science are no longer the stepping-stones and handmaidens of the clinicians.

Shannon and Kidd ("Medical research in perspective," Science, **124**:1185, 1956) point out that the dollar volume for medical research in the United States has increased from some $40 million to over $240 million in the past 15 years. During this period the federal government's share of support has risen from seven percent of the total to over 40 percent. During the same period, the large volunteer health agencies have greatly increased their support of medical research but the relative contribution of the older endowed foundations has declined.

Federal support of medical research during 1955 was derived from five administrative agencies—the Department of Health, Education, and Welfare ($64 million); Department of Defense ($31 million); Atomic Energy Commission ($11 million); Veterans Administration ($6 million); and the National Science Foundation ($1 million). This diversity of support assures a variety of viewpoints which would be lacking if a single centralized agency were responsible for the direction of all research. On the other hand, it causes a duplication of administration and a lack of co-ordination which could result in increased and unwise expenditure of research funds. It is a tribute to the members of the various advisory councils and the staff members of these groups that these funds have been used wisely and usefully, divorced from political control and favor, and devoted in their entirety to the fields for which they were appropriated.

Research in industry during 1955 approximated $80 million. Much of this was concerned with process research, product development, and the like. However, clinical ophthalmology and medicine unquestionably benefit from many of these studies. Undoubtedly there is considerable duplication of effort by various pharmaceutical organizations, but the remarkable development of new drugs, such as the steroids and antibiotics, could not have occurred, or would have been much delayed, if industry had not recognized the importance of exploration of the possibilities of these compounds.

The support of research by the universities and their hospitals is paramount in medical studies. In 1955, they spent approximately $100 million for research. Of this, $20 million came from endowment, $30 million from philanthropy, and $50 million from the federal government. The most important factor of all is not reflected in these dollar figures—the physical plants and laboratory space provided by the universities and hospitals. The one factor which more than any other would appear to limit research, particularly in oph-

thalmology, which has not a strong research tradition, is the lack of laboratory space. In nearly every medical school doing ophthalmic research, the eye laboratories are found scattered in basements, in tolerant basic science departments, and wherever the ingenuity and persuasiveness of the department head can make room. The need for more laboratory space has been recognized by federal legislation which provided $90 million over a three-year period to the Public Health Service for the construction of research facilities. This money is, however, provided on a dollar for dollar matching basis so that "hard" endowment funds or private funds must be first obtained before such aid is available. Ophthalmology has lagged in the solicitation of such funds and there seems to be no early solution to the problem of providing the roof and walls needed for laboratory space.

Universities, too, are loath to erect laboratories and provide research facilities for which there is no long-term support available. At present federal funds are obtained without undue difficulty for definite research projects but to build laboratories dependent upon favorable legislation for continuity of support does not attract medical administrators.

Another factor not reflected in dollar statistics of the universities is the financial contribution of the investigator himself, or his employer, to medical research. Hard endowment money is required to pay the investigator or, alternatively, he must create income by clinical practice. Frequently, the demands of this practice, either private or institutional, are far beyond those required for the adequate teaching of students and residents but are demanded for the support of his laboratories, for the assistance of his less clinically productive colleagues, and for the day-by-day clerical help, technicians, and staff necessary for research. Thus, nearly every ophthalmic investigator in this country devotes a portion of his day to clinical activities which, in turn, indirectly support his own or his institution's research. No ophthalmologist begrudges this clinical activity since he has been trained as a physician, but this labor must be recognized as a definite contribution to medical research which, when excessive, deprives him of time and contemplation that should be devoted to the laboratory.

Frank W. Newell

THE OXFORD OPHTHALMOLOGICAL CONGRESS

Oxford, England, 1957

The 42nd annual meeting of the Oxford Ophthalmological Congress was held in Oxford July 1st, 2nd, and 3rd at the University Laboratory of Physiology, under the mastership of Sir J. W. Tudor Thomas. There were approximately 200 members and guests present, 40 of whom came from overseas from as far away as India, Japan, and China to as near as the Continent. Six of the overseas members were from the United States. The men were accommodated at Balliol College and the lady members were accommodated at Holywell Manor. Meals were served in the beautiful old Hall of Balliol. The weather was sunny but warm.

Following a very gracious welcome from the master, a discussion on "The facial neuralgias" ensued. The opening discussers were Mr. E. F. King of London, Dr. W. Ritchie Russell of Oxford, and Mr. G. F. Rowbotham of Newcastle. These interesting papers produced lively discussion. Following this, Prof. Marc Amsler of Zurich in his paper, "Disease and time," showed the importance of serial photographs of different eye diseases especially those involving the fundus, illustrating the importance of the time factor in the morphologic evolution of vascular and tissue lesions of the eye. Mr. J. Horton Young of Nottingham described a new surgical procedure for the intracapsular extraction of cataract which consisted of incision through the ora serrata, the ora serrata zone, and removal of the lens by what

could be called the posterior route. He reported successful results in two cases.

Mr. A. G. Leigh of London and Mr. J. W. Ridge of Bristol described some problems of the preservation of corneal tissue by freezing. Their work indicates that corneal tissue can be preserved by freezing but there are many uncertain problems still remaining.

Dr. Howard Reed of Winnipeg and Dr. J. E. L. Bendor-Samuel of Winnipeg read a paper on "The detection of glaucoma before evidence of visual impairment." This consisted of a plea for routine tonometry. In 2,000 consecutive patients they found the incidence of glaucoma to be 3.5 percent, and in 1.8 percent of their patients the presence of glaucoma would have been missed were it not for routine tonometry.

Mr. Rupert Parry of Cardiff gave an exceedingly interesting paper on the long-term end-results of concomitant strabismus. This was an analysis of cases 10 years after the termination of treatment, both operative and nonoperative, and he emphasized the difficulty entailed in collecting the cases and making the follow-up analysis.

Mr. P. D. Trevor-Roper of London, in his paper on "Hypothermia in hamsters and the ocular response to freezing and resuscitation," described fascinating experiments where hamsters had been frozen solid, with ice-crystals forming in most of the body cells, followed by thawing and resuscitation. The only major ophthalmic change found was the development of subcortical cataract. There was no apparent significant variations in the caliber of the retinal vessels during freezing and thawing.

On Tuesday, July 2nd, Mr. Harold Ridley of London in his paper on "Fundus photography" described the new Zeiss camera and demonstrated a series of fundus photographs taken with this camera. It is good to see marked improvement in the field of fundus photography.

Dr. G. Meyer-Schwickerath of Bonn, Germany, gave a thrilling paper on "Further progress in the field of light coagulation." This consisted of an illustrated report of 560 cases treated by light coagulation with the instrument that he has devised for this purpose. He showed successful results in the sealing of retinal tears, in the destruction of various tumors of the ocular fundus, the destruction of proliferative retinal vessels, the treatment of inflammatory ocular disease, coagulation of the iris to produce a new pupil, and coagulation of tumors of the iris and skin. He showed a remarkable film of the action of light coagulation on the rabbit's retina and one could see the actual destruction of retinal vessels by this method.

The 1957 Doyne Memorial Lecture was delivered by Dr. Derrick Vail of Chicago whose subject was "The zonule of Zinn and the ligamentum hyaloideo-capsulare of Wieger: And their importance in intracapsular cataract extraction." The lecture was very well received. Following the lecture the Doyne Memorial Medal was presented.

It had been planned that the master would present the Sir Norman McAlister Gregg Prize and Medal on behalf of the Ophthalmological Society of New South Wales to Dr. Maurice E. Langham. Unfortunately Dr. Langham was unavoidably absent.

Mr. B. W. Rycroft of London gave a paper on "The surgery of congenital ptosis," illustrated by a good film. Dr. Edmund B. Spaeth of Philadelphia discussed the treatment of monocular aphakia with the use of a strong contact lens.

The day's scientific meeting concluded with an innovation, "Any questions." Members were invited to submit questions which would be answered by any of the members of the society who wished to express an opinion. There was time for 12 questions and a surprisingly good discussion ensued. The experiment was a success and the members voted to continue it in future programs.

On Wednesday, July 3rd, a discussion on "The rehabilitation of the blind and partially sighted" was opened by Dr. Dorothy R. Campbell of Coventry, Mr. T. D. Drake, a member of the Rehabilitation Centre for the

Blind in Torquay, and Prof. W. J. B. Riddell of Glasgow. This panel discussion was admirable and most instructive and created excellent discussions. Mr. J. E. H. Cogan of Tunbridge Wells discussed "Phakoerisis" and showed a film from Barraquer's Clinic. The scientific program ended with a paper by Mr. R. Pitts Crick of London, read in absentia, on "Parabolic projection in visual field examination."

The social side of the congress left nothing to be desired. On the afternoon of the first day, tea was served in the lovely garden of Balliol College. The afternoon of the second day a tea party was held in the gardens of Holywell Manor and in the evening the annual banquet of the congress was held in the dining hall of Balliol. So far as is known no sconces were drunk and there was no effort to compete with an incident that occurred in the Hall of Balliol College on May 29th when, according to a letter that appeared in *The London Times Weekly Review*, a Scotsman sconced a Canadian. The author of the letter, G. C. Bolton, goes on to say that each of them drank seven consecutive sconces, each of two and one-half points of beer, the total consumed was 35 pints over a period (including rests) of 70 minutes approximately. Both contestants were conscious and comprehensible afterward. No precedent for this achievement could be found in the college annals. Is this a University record? On the contrary, all the members and ladies of the congress showed exemplary behavior. The speeches given were skillfully done and everyone had a wonderful time.

Associated with the scientific program of the congress there was an exhibition of ophthalmologic instruments and appliances by well-known London firms. There were a lot of new devices shown by the skillful manufacturers of old ones. The popularity of this exhibit was manifested by the crowded passage-ways separating the exhibits.

The congress also celebrated the 100th anniversary of the birthday of Robert Doyne, founder of the organization in 1909. It was a happy and gracious event. Its growing size emphasizes the importance and affection that this congress holds in the hearts of ophthalmologists throughout the world and it can be truly called, the Junior International Congress of Ophthalmology.

Derrick Vail.

OBITUARY

JOHN HERBERT WAITE, M.D. (1889-1957)

John Herbert Waite, one-time professor of ophthalmology at Harvard University and chief of ophthalmology at the Massachusetts Eye and Ear Infirmary, died in Boston, February 23, 1957, in his 68th year. He was born in Bellingham, Pennsylvania, November, 1889.

After graduating from Bucknell College, magna cum laude, he entered Harvard Medical School from which he received his M.D. degree in 1916. His first postgraduate work was in pathology under Dr. Frederick B.



JOHN HERBERT WAITE, M.D.

Mallory at the Boston City Hospital. He then became interested in parasitic diseases and joined the staff of the Rockefeller Foundation to study hookworm in the United States. After completing this study he was sent to New Guinea, India, China, and Japan for further investigation of parasitic problems.

Following this sojourn in the Orient he came home determined on a career in internal medicine. After a medical residency in Albany, New York, he decided to go into ophthalmology and became a resident at the Massachusetts Eye and Ear Infirmary. Upon completion of this training he entered the private practice of ophthalmology with Dr. George Derby of Boston, and was immediately successful. He joined the teaching staff at Harvard and rose rapidly through the ranks eventually to succeed Dr. Derby as head of the department upon the latter's death in 1931. He also became chief of the ophthalmologic service at the Massachusetts Eye and Ear Infirmary at the same time. For 10 years he administered this joint responsibility with great ability and energy. In 1936 his alma mater, Bucknell, conferred upon him an honorary degree of Doctor of Science.

A progressive deafness, resulting from an attack of sprue in the Orient, made it more and more difficult for him to attend medical meetings and take part in the discussions. In 1941, he resigned his academic positions and devoted his time to private practice.

While not a prolific writer, Dr. Waite was the author of 19 papers, his major work being "The visual mechanism in diabetes mellitus: A study of 2,000 diabetics and 457 nondiabetics." This paper, written in collaboration with Dr. William P. Beetham in 1935, served as a standard reference on the subject for many years.

He was a member of all the major national ophthalmologic societies and was president of the New England Ophthalmological Society in 1939. He also served on the editorial board of the *Archives of Ophthalmology* from 1929 to 1942.

One of Dr. Waite's outstanding traits was diligence. He labored hard and long in the administration of his department, often driving himself to the point of exhaustion. He was extremely erudite and thorough, his papers showing the unmistakable stamp of a scholar. In his relations with his colleagues he was kindly and helpful, always willing to share his great fund of knowledge. Those who were his contemporaries and his students will remember his inspiring example of giving his all for the advancement of our special field of medicine.

Edwin B. Dunphy

CORRESPONDENCE

PTOSIS AND VERTICAL MUSCLE ANOMALY

Editor,
American Journal of Ophthalmology;

I read with great interest in Part I of the April, 1957, issue of THE JOURNAL, page 630, in the report of the meeting of the Chicago Ophthalmological Society, the case presented by Dr. Warren Binion of ptosis and vertical muscle anomaly. The reason given for presenting that case was "we feel it is most important to correct a vertical muscle anomaly before correcting a ptosis of the lid."

I enclose herewith photographs (before and after) of a child who had a left hori-



Fig. 1 (Tomkin). Ptosis and vertical muscle anomaly. (Left) Before operation. (Right) After operation.

zontal muscle defect (left convergent concomitant strabismus) with ptosis. The squint was corrected by advancing the left external rectus and the ptosis disappeared.

In view of these two cases would it be presumptuous to suggest that in all cases of ptosis associated with any extraocular muscle defect, the latter should be corrected first.

Yours faithfully,

(Signed) Harris Tomkin,
Surgeon,
Royal Victoria Eye and
Ear Hospital,
Dublin, Ireland.

BOOK REVIEWS

AN ATLAS OF DISEASES OF THE EYE. By E. S. Perkins and Peter Hansell. Boston, Little, Brown and Company, 1957. 85 pages of text, profusely illustrated with color plates, a few illustrations in black and white, index. Price: $10.00.

The authors of this excellent atlas are coworkers in the Institute of Ophthalmology, University of London. It is fitting, therefore, that Sir Stewart Duke-Elder should write a handsome foreword, since he was responsible for the original plan. The various parts include: lids and orbit, conjunctiva and cornea, uveal tract and lens, retrolental fibroplasia, the fundus in systemic disease, and the fundus in local disease.

The illustrations are for the most part superb, with good color values emphasized by the gray paper on which they are printed. They represent excellent choices to illustrate the text that accompanies them on the opposite pages. Some, especially the fundus pictures, are reproduced from drawings, others are reproduced from colored photographs in good focus.

An atlas of this nature is excellent for teaching purposes and quick reference. The only other available and somewhat similar atlas is that by Rudolf Thiel, the second edition of which appeared in 1948. Since this has a German text, many of us are not familiar with it. I should say this atlas by Perkins and Hansell compares very favorably with Thiel's, in spite of its more modest approach.

The cost of this atlas is very reasonable. If it had not been for the "generosity and public spirit of the firm of Roche Products Limited," it would have been prohibitive. All English-reading ophthalmologists should be grateful to this firm for having made this valuable endeavor available to us.

Derrick Vail.

STRUCTURAL ANALYSIS OF BINOCULAR DEPTH PERCEPTION (Strukturanalyse der Tiefenwahrnehmung). By Dr. Linschoten. (With an introduction by Prof. Dr. W. Metzger.) Groningen, Holland, J. B. Wolters, 1956. Distributing agent for the United States: Gregory Lounz, 11 East 45th Street, New York 17, New York. Clothbound, 573 pages, 226 illustrations, comprehensive bibliography. Price: $10.00.

This scholarly book is the result of the author's investigations at the Psychologic Institute of the University of Utrecht, 1951-1955. His original subject was a re-examination of the Panum-effect. However, such a partial solution of his problem proved impossible for the full understanding of depth perception.

He questions Hering's physiologic approach and sets out to prove that corresponding points do not necessarily require identical visual directions: one is able to perceive diplopia with corresponding retinal points. The point of the collective image cannot be calculated from the depth values of the individual retinal points. Linschoten substitutes the static theory of Hering with his own dynamic concept. "In the binocular field an attractive force operates between all image points pertaining to the left eye and points pertaining to the right eye."

This attraction theory also easily explains some discrepancies in the Panum-effect. The

attractive force increases as the distance between disparate points decreases, a fact that enables one to predict various spacial forms of the Panum-effect. The latter is absent when distances become very large. The attraction theory gives a satisfactory explanation for different thresholds in depth perception. Single and double vision depend on whether the restrictive force increases more quickly than the attractive force.

Linschoten quite interestingly proves that neither the (hypothetical) sense of accommodation nor the (hypothetical) sense of convergence are essential factors in depth perception. Varying states of convergence suggest an attraction between double images, whereas convergence can be partly explained on the basis of this attraction.

Linschoten bases his new theory on a series of ingenious experiments. Written by a psychologist, the treatise is of primary interest to the psychologist. Nevertheless, this field overlaps with the sphere of interest of the physiologist and the ophthalmologist. It is not an easy subject but one that—in spite of its lucid presentation—requires full concentration. The volume is not a textbook nor reference book but should be perused in its entirety by those interested in its topic. For that reason, the reader will find the table of contents an adequate substitute for the missing index.

Stefan Van Wien.

THE PROBLEMS OF VISION IN FLIGHT AT HIGH ALTITUDE. By Thomas C. B. Whiteside. London, Butterworth's Scientific Publications, 1957. Price: $5.00.

This is a timely and very readable little book. Timely, because of the present great interest of all scientists in the physiologic problems of flight at extreme altitudes and in space.

Dr. Whiteside combines the talents of an extremely competent visual scientist with those of a jet pilot qualified to fly high performance aircraft. In this book he reports the results of his research both at altitudes above 40,000 feet and in the laboratory on the ground. His practical approach to the visual problems involved makes interesting reading.

He points out that most of the visual problems of lower altitudes are present at higher altitudes and include the effects of hypoxia, linear and angular acceleration, imperfect distance judgment, inadequate vision at night, glare, and the lag in visual perception. At high altitudes, however, are added the problems produced by reversal of the brightness in the field of vision and the involuntary accommodation occurring in the eye with an "empty visual field." At high altitudes the clouds and earth beneath are brighter than the sky above and this reversal interferes with the ability to see instruments in the cockpit. This occurs because of glare and decreased instrument illumination. The so-called "space myopia," due to the involuntary accommodation, results in failure to detect other aircraft in the sky at normal detection distances. Every ophthalmologist will enjoy Dr. Whiteside's description of his experimental procedure utilized in resolving the factors involved. There may be some minor disagreements with details but most authorities will find this book stimulating, readable, and useful.

The book is well illustrated and there is a good bibliography.

With the increasing number of flights being made at altitudes above the stratosphere, this book will help to keep ophthalmologists and specialists in aviation medicine informed concerning these new visual problems. It is highly recommended.

Victor A. Byrnes.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Saito, K. **Vitamin B_1 and the retinal metabolism.** Acta Soc. Ophth. Japan **61**: 113-118, 223-227 and 344-347, Feb., March and April, 1957.

This is a study on the relation between the retinal metabolism and vitamin B_1 in chickens. In the first experiment chickens were fed a vitamin B_1 deficient diet. After 17 to 20 days the animals were killed and the retinal metabolism was measured by Warburg's method. A 30 percent reduction was demonstrated in QO_2, but not in $Q_M^{O_2}$. When 0.5 mg. vitamin B_1 was given daily for three days to such chickens, there was a partial recovery (13 percent in the QO_2). When the retina was examined one hour after a single injection of the vitamin in normal chickens, there was little change in the retinal metabolism. A continuous administration of the vitamin for one week seemed to increase the QO_2 of the retina to some extent, though not definitely.

Finally, the author examined the in vitro effect of the vitamin on the retinal metabolism, adding the vitamin in various concentrations to the suspending medium for Warburg's determination. He observed only an indefinite decreasing tendency of the QO_2. (8 tables, 67 references)

Yukihiko Mitsui.

Sorsby, A., Newhouse, J. P. and Lucas, D. R. **Experimental degeneration of the retina. I. Thiol reactors as inducing agents.** Brit. J. Ophth. **41**:309-312, May, 1957.

Injection of sodium iodoacetate in laboratory animals results within a few minutes in complete loss of function of the retina. This drug reacts with thiol and this study is made to determine if other drugs which react with thiol can produce the same destructive retinal effects. Sublethal doses of 15 such drugs were given intravenously to rabbits and rats. In the latter animal no effects were noticed. In the rabbit the results were also negative except that bromoacetate caused some ophthalmoscopic and histologic changes which were very mild and will be explained in detail in a later paper. (1 table, 16 references)

Morris Kaplan.

Uzman, L. L. and Jakus, M. A. **The Kayser-Fleischer ring: a histochemical**

and electron microscopic study. Neurology 7:341-355, May, 1957.

The Kayser-Fleischer ring in hepatolenticular degeneration has been studied histochemically, but will not survive the usual alcohol or ether treatment. Several investigators have shown traces of copper in the cornea, liver, and brain. In the present series, two corneas were stained by a modified rubeanic acid and by a phosphotungstic acid method. The distribution of copper was then studied in glass-cut sections under the electron microscope at from 16,000 to 70,000 diameters magnification. Photographs show a large amount of copper in the substantia propria which is alcohol insoluble, but soluble in versene or dilute acid. The copper in the ring was in a different form. The Kayser-Fleischer copper particles (not a salt) were arranged in Descemet's membrane in two parallel zones of unequal width close to the endothelium. There were fine channels in Descemet's membrane, but these did not affect the distribution of copper.

The particles evidently diffuse from the anterior chamber as ionic copper, loosely bound to albumin, by a means related to the Liesegang phenomenon. (9 figures, 36 references) Paul W. Miles.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

ten Doesschate, G. and ten Doesschate, J. **The influence of the state of adaptation on the resting potential of the human eye.** Ophthalmologica 132:308-320, Nov., 1956.

The existence of a resting potential (RP) of the mammalian eye has been known since the work of Du Bois-Reymond in 1849. The difficulties inherent in its recording in the human eye deterred many subsequent investigators until W. R. Miles conceived the idea of recording ocular potentials by means of two stationary, symmetrically placed surface electrodes which are influenced by changes in position of the eyes. During horizontal versions the anterior and posterior poles of the eyes change their relative positions with regard to the electrodes and cause a change in the RP which Miles considered a relative measure of the RP. The recent developments in ocular electromyography revived interest in measurements of the RP.

The paper under review concerns itself with measurements of changes in RP produced in human controls by standardized horizontal movements. The two electrodes were attached to the skin of the outer canthi. The variable in these measurements was the state of adaptation. Fairly consistent changes were observed during dark adaptation. The RP dropped to a minimum at the end of the first 10 minutes; then it rose to a plateau slightly below the value prevailing at the end of the preadaptation period. These and other changes in RP during adaptation suggest that the resting potentials of the two types of visual cells are opposite in direction, the rods carrying the greater positive and cones the greater negative charge. (5 figures, 18 references) Peter C. Kronfeld.

François, J., Verriest, G., Mortier, V. and Vanderdonck, R. **The frequency of congenital dyschromatopsia in man.** Ann. d'ocul. 190:5-16, Jan., 1957.

The authors report a group of 1,243 young male students who were examined for defective color vision. Of this group 112 (8 percent) were found to be color defective. A second group of 21 cases of congenital dyschromatopsia were studied to determine the relative frequency of the various types of color deficiency. Of the total of 128 cases thus accumulated 28 percent were dichromats (11 percent protanopia and 17 percent deuteranopia) and about 70 percent abnormal trichromats (12 percent protanomaly, 57 percent

deuteranomaly and 1 percent tritanomaly). (5 tables, 72 references)

David Shoch.

Gilbert, Jeanne G. **Age changes in color matching.** J. Gerontol. **12**:210-215, April, 1957.

Children under the age of 15 years are not as accurate as adults in matching various shades of spectral color. In a group of 355 people tested, the optimum age was 25 years; after this, color discrimination diminished in a straight line until age 90 years. Statistical scores for yellows dropped from 60 at age 40 years to 35 at above 80. The worst decline was for blue. The score dropped from 56 to 29. Statistical methods showed homogeneity of this group. No significant differences were correlated with sex. There was, however, a wide variation in color matching ability among individuals of each age group. (1 figure, 5 tables, 8 references)

Paul W. Miles.

Graff, T. **The role of the cornea-vertex distance in near glasses.** Arch. f. Ophth. **158**:495-501, 1957.

These are geometric optical calculations leading to the following rules. A change in distance between eye and eyeglass for near vision has an effect on the vertex power opposite to that on glasses for far vision. This holds true if the numerical value in diopters of the distance of the object is larger than one half the positive vertex power of the eyeglass. (4 figures, 2 tables, 3 references) Ernst Schmerl.

Malbrán, J. **The treatment of amblyopia (pleoptics).** Arch. oftal. Buenos Aires **31**: 317-326, Dec., 1956.

Being itself a summary presentation, this paper cannot very well be further abstracted. It deals with the management of amblyopia—either unilateral or bilateral, and associated with strabismus, nystagmus or with diverse organic lesions which do not seem to justify entirely the prevailing functional loss—by means of Bangerter's and Cüppers' methods.

The former's methods (adequately exposed in his book "Amblyopiebehandlung," Basel, S. Karger, 1953, pp. 30-54) consists mainly in an intense stimulation of the macula succeeded by training of the definition capacity; the visual stimuli are supplemented and propped by auditive, tactile, proprioceptive and mnemonic stimuli. Cüppers' technique, the development of which may be followed through the several reports made by this author to the Giessen Medical Society since 1954 (cf. also Cüppers, C. Moderne Schielbehandlung. Klin. Monatsbl. f. Augenh. **129**:579-604, 1956), is essentially aimed at the restoration of central fixation and good visual acuity through the production of negative after-images; a reconditioning of the eye and limb movements must be carried out after a normal visual direction has been firmly established. Eighteen cases so treated are briefly described.

A. Urrets-Zavalía, Jr.

Paguet, Colette. **The role of simultaneous macular perception and its treatment in headache.** Ann. d'ocul. **190**:43-51, Jan., 1957.

Many patients complain of headache, nausea and discomfort with use of the eyes and show no organic disease on routine ophthalmologic examination. The author believes that many of these have weak simultaneous macular perception. She has collected 255 such cases, in 93 of which the patients were orthophoric and in 162 heterophoric. In most cases stimulation of the fusion sense improved the simultaneous macular perception and relieved the symptoms. The author further states that she believes that a defect in simultaneous macular perception is the underlying difficulty in the production of heterophoria and that the group of ortho-

phoric patients she reports would develop a heterophoria if left untreated. (1 table)
David Shoch.

Pisano, Elisa. **Gonioscopic observations in degenerative myopia.** Rassegna ital. d'ottal. **25**:357-367, Sept.-Oct., 1956.

A gonioscopic study was made of 19 cases of degenerative myopia arising quite precociously in members of the same family, many of whom presented alterations of the globe, such as sclerochoroiditis, pigmentary changes, dystrophic macular changes and separation of the retina. Ten of the cases were seen in members of the same family and nine in members of another family. The various changes noticed in the angle of the anterior chamber are described and all point to a defective development of the angle of the chamber. (3 figures, 30 references)
E. M. Blake.

Polack, A. **Adjustment of the color curve in the chromatic triangle of Maxwell.** Ann. d'ocul. **190**:1-4, Jan., 1957.

The author feels that the Maxwell chromatic triangle is physical and not physiologic in nature. He gives as an example the fact that equal quantities of blue and green do not result in the complement of red but that it is necessary to use almost twice as much green as blue. He proposes a new curve, which he calls the rectified physiologic curve. (1 figure)
David Shoch.

Rokitskaya, L. **Dark adaptation in hypertension.** Vestnik oftal. **2**:30-36, March-April, 1957.

The study of dark adaptation and its relative changes with disturbance of other functions of the eye was made on 72 patients, from 40 to 68 years old, who had various forms of hypertension. Fundus and vision were examined in all patients. Visual fields were done on 113 eyes; in 80 eyes there was constriction of the field of vision on the temporal side. The author found that dark adaptation as one of the indicators of the function of the central nervous system, was changed considerably in hypertension. There is an inverse relationship between the height of the general arterial pressure and the condition of dark adaptation. There is no absolute or regular relation between the dark adaptation and the degree of fundus changes; this relationship is relative and manifests itself in severe abnormality of the fundus. There is no definite parallelism between the condition of dark adaptation and the degree of change of central and peripheral vision. These changes are probably associated with the functional disturbance of the visual centers. Oxygen deficiency, characteristic of hypertension, probably is the factor which gives rise to the functional disturbance of the visual centers. (3 drawings, 3 tables)
Olga Sitchevska.

Shimizu, K. **The effect of artificial light on color test plates.** Acta Soc. Ophth. Japan **61**:614-660, May, 1957.

This is an analysis of various pseudoisochromatic tables under an artificial light of 2,848°K color temperature. Shimizu examined Ishihara, Ohkuma, Oguchi and Stilling plates and concludes that, under the artificial light, the screening plates of the tables would hardly be read by protanopes and conversely they would more easily be read by deuteranopes than under daylight. The classification of the color blindness and anomalies by means of other plates may also become inaccurate under the artificial light and protanopes may be erroneously diagnosed as deuteranopes. (30 figures, 41 tables, 45 references)
Yukihiko Mitsui.

Umetani, S. **The influence of sound on accommodation.** Acta Soc. Ophth. Japan **61**:292-295, March, 1957.

The near point and the time of accommodation are measured giving sounds of various strength by an audiometer. A sound up to 40 decibels makes the near point closer and the time of accommodation shorter, while a sound louder than 40 decibels does the opposite. (7 figures, 7 references) Yukihiko Mitsui.

5

DIAGNOSIS AND THERAPY

Dunphy, E. B. **Radioactive isotopes in ophthalmology.** New York Acad. Med. Bull. **33**:310-324, May, 1957.

After a short review of atomic theory, the author describes methods of experimental physiology with radioactive isotopes. The ones selected have such a short period of activity, and are excreted by the kidneys so rapidly, that they do no harm in the body. The passage of radioactive sodium through the ciliary body was studied in this way by Kinsey in 1942. His results indicated an aqueous flow of only 4 $mm.^3$ per minute instead of 50, and completely changed the accepted diffusion theory of aqueous formation to a secretion theory. Some sodium enters the eye in the region of the optic nerve. Sodium enters the cornea at the limbus and not from the aqueous. The use of isotopes in the detection and treatment of malignant tumors of the globe has not been completely satisfactory, but work is still in progress. Paul W. Miles.

Nairac, M. L. **Twenty-six cases of extra-conjunctival implants.** Brit. J. Ophth. **41**:182-185, March, 1957.

During the past two years, 26 cases of the author's implant have been completed and during that time not one implant has been extruded. Nairac believes that these have been completely successful. The four muscles are now sutured together behind the implant which is extraconjunctival but has four brackets reaching back through the conjunctiva. (4 figures, 1 table, 3 references) Morris Kaplan.

von Nordheim, R. W. **The treatment of acute iridocyclitis, episcleritis and other eye diseases with naphazoline.** Ophthalmologica **132**:327-332, Nov., 1956.

In two cases of acute iridocyclitis and one case of episcleritis, naphazoline, better known in the USA under the name of privine, seemed to enhance the effect of atropine. (3 figures, 6 references)
Peter C. Kronfeld.

Pedler, Christopher. **A method for the direct observation of retinal vessels in the experimental animal.** Brit. J. Ophth. **41**: 174-178, March, 1957.

In 1953, Ashton and his co-workers reported studies on retinal blood vessels made by direct observation by means of a stereoscopic microscope. In their studies on retrolental fibroplasia they were able to photograph vessel changes as they occurred. Since the technique has many applications in other retinal studies, the necessary apparatus has been improved upon and Pedler here describes in detail the pattern of the lighting system, the animal chamber, the microscope, the ciné camera and the control gear. The technique involves removing the anterior ocular structures, including the lens, and replacing these with a transparent window through which the observations take place. (6 figures, 3 references)
Morris Kaplan.

Pettinati, Sergio. **Radiographic differential diagnosis of intraocular calcification.** Rassegna ital. d'ottal., **25**:374-388, Sept.-Oct. 1956.

Three groups of calcification are recognized, 1. inflammatory, 2. calcification of the lens, and 3. neoplastic calcification. This differentiation is not always possible. Group 1. is recognized where a true inflammatory process precedes the califica-

tion. Bone formation in the lens is thought to be due to trauma after which newformed vessels can enter. It is possible to find radiologic evidence of intraocular calcification in 75 to 80 percent of cases of glioma. (Pfeiffer) (7 figures, 25 references) E. M. Blake.

Redslob, E. **The antibiotics are not a panacea.** Ann. d'ocul. **190**:52-54, Jan., 1957.

The author makes a plea for the more discriminate use of antibiotics and lauds the virtues of the old preparations such as silver nitrate and yellow oxide of mercury. He reports a case of unilateral "Schwellungskatarrh" of six months' duration that was completely cured in six weeks solely by thrice daily irrigations with ⅛ percent silver nitrate for ten minutes. David Shoch.

Santalices Muniz, Faustino. **Sharp instruments in ocular surgery.** Arch. Soc. oftal. hispano-am. **16**:1310-1338, Dec. 1956.

This is an extensive description of the metallurgic properties of the various alloys used in the manufacture of ophthalmic instruments. Small instruments, such as corneal needles, keratomes and scissors, should be made of fine-grained metal, with regular structure, possessing an optimal degree of elasticity, in order that the instruments endure the pressure incident to the manipulations to which they are subjected. The various alloys of iron, chromium and nickel have their advantages and disadvantages. Stainless steel with a 12 to 17 percent content of chromium is very suitable for the manufacture of surgical instruments. The alloy used by Grieshaber has a superficial purity which permits extreme sharpening and polishing. Iron with a carbon content which is of fine grain and is easily tempered would be ideal, were it not so susceptible to rust. Plating overcomes this objection, but plated instruments cannot be properly sharpened. (22 figures, 18 references) Ray K. Daily.

Veris, Everett R. **Dangers in the use of topical corticosteroids in disorders of the eye.** South. M. J. **50**:646-647, May, 1957.

The topical administration of cortico steroids is most valuable in certain disorders of the eye but the combined use of corticosteroids and antibiotics or antiseptics is not justified. It is of the utmost importance to make a diagnosis before such powerful and potentially dangerous drugs are used. (3 references) Irwin E. Gaynon.

Zagora, Edward. **The Zagora rod test.** Brit. J. Ophth. **41**:188-189, March, 1957.

The author describes an instrument similar to the Howard-Dolman depth perception test in which there are three rods instead of two. Two of these are stationary and one is movable. By a series of pulleys, the movable rod is aligned horizontally as well as vertically with each of the other two and the accurateness of the attempt is read on a scale. (1 figure, 1 reference) Morris Kaplan.

6

OCULAR MOTILITY

Jonkers, G. H. **The treatment of amblyopia with the euthyscope: first impressions.** Ophthalmologica **132**:322-326, Nov., 1956.

The amblyopia so frequently encountered in cases of strabismus varies with regard to type and degree. For the type associated with eccentric fixation Bangerter introduced a form of therapy that consists of blinding the fixating area and stimulating the anatomically normal, but functionally inactive fovea. For this purpose Cüppers has designed the euthyscope which is essentially an ophthalmoscope with a powerful light source and adjustable diaphragms. In the routine form of

treatment an area of about 15 degree radius around the patient's fovea is blinded for about 30 seconds, while the very central foveal area is carefully shaded or spared. The negative afterimage elicited by this exposure is a central light area surrounded by a dark ring which includes the eccentric point of fixation. Now optotypes of suitable, gradually diminishing size are offered to the fovea. That is the principle of euthyscopic therapy with which good results have been reported by Sevrin (Société Belge d'Ophtal. 109:11, 1955) and Lang (Ophthalmologica 131:261, 1956). The present author has observed some visual improvements, but no change in the mode of fixation if it was eccentric at the beginning of the treatment. (1 table)

Peter C. Kronfeld.

Larmande, A. M. and Margaillan, A. **A study of diplopia by the projection of a luminous arrow.** Arch. d'opht. **16**:704-706, 1956.

The authors discuss the history of diplopia tests and describe in detail the advantages and disadvantages of 1. the classic diplopia test with head fixed and object mobile, and 2. the test of Landolt with object fixed and head rotated by the observer. They offer a new technique according to which the test object is replaced by a test image, projected in the form of a luminous arrow on a graduated screen, or more simply on a plane vertical or horizontal surface. The test is particularly well adapted to the study of bed patients. With this test the diplopia is normally analyzed at a distance of six feet or greater to minimize the accommodation effect, but at 30 to 50 cm. the diplopia field can be explored by means of the image produced by an ophthalmoscope.

P. Thygeson.

Lyle, T. K. and Foley, J. **Prognosis in cases of strabismus with special reference to orthoptic treatment.** Brit. J. Ophth. **41**: 129-152, March, 1957.

A study of the history will indicate from the following factors what results can be expected: 1. the age of the patient; 2. the age of onset of the strabismus; 3. the mode of onset: whether intermittent or constant from the onset and 4. the duration of the squint before the muscles are brought into alignment. In non-paralytic strabismus the various categories can be fairly well typed as to prognosis and as to type of treatment that should be followed. In accommodative convergent squint, prognosis for binocular single vision is very good with and without surgery depending on how much over-accommodation is present. Orthoptic treatment may be valuable in all types. In non-accommodative squint of early onset, binocular vision is unlikely unless surgery is done very early. When the onset is later, after two to three years, binocular vision may be developed by orthoptics. When it occurs still later, or in adult life, binocular vision should be easily established by orthoptics if the eyes have been aligned surgically. In primary divergent strabismus prognosis is good. Operation is needed in most cases, though orthoptics may benefit in the intermittent type. In congenital paralytic strabismus, if binocular vision is present, as is indicated by head tilting, the prognosis is good after surgery, whereas if binocular vision is absent the prognosis is poor. (9 tables, 1 reference). Morris Kaplan.

7

CONJUNCTIVA, CORNEA, SCLERA

Agarwal, L. P. and Mailk, S. R. K. **The treatment of pterygium with hyaluronidase.** Ophthalmologica **132**:382-386, Dec., 1956.

Subconjunctival injections of about 6 viscosity units of hyaluronidase ("Permease" of Cilag Hind Ltd.) in .25 cc. of

2 percent procaine were given in 27 cases of pterygium once a week for a total of four weeks. In early pterygia, barely encroaching upon the cornea, the hyaluronidase therapy seemed to have a favorable effect, but not in more advanced cases (cf. Carriker, Am. J. Ophth. 35:1765, 1952). (2 references) Peter C. Kronfeld.

Hartmann, E. **Band-shaped opacity of the cornea. Comments on the article by M. Bonnet.** Arch. d'opht. **16**:724, 1956.

Commenting on an article by M. Bonnet in the January, 1956, issue of this journal, Hartmann strongly urges the use of 2 percent hydrochloric acid in the treatment of band dystrophy. He disagrees with Bonnet who has advocated the use of lamellar keratoplasty as the treatment of choice. P. Thygeson.

Holmes, Wendall. **Herpes simplex of the cornea.** Mississippi Doctor **34**:300-303, April, 1957.

The history, morphology and histology of this condition are briefly reviewed. Braley's classification into four groups is used: acute primary blepharokeratoconjunctivitis, recurrent dendritic, dendritic with disciform keratitis and uveitis, and keratitis metaherpetica. Each of these is described in some detail. The various methods of treatment advocated are enumerated; cauterization with ether or tincture of iodine are the methods of choice. In the discussion it is suggested that vitmain B_{12} may be of some help. (10 references) Harry Horwich.

Jones, B. R. and Stevenson, C. J. **Keratoconjunctivitis sicca due to sarcoidosis.** Brit. J. Ophth. **41**:153-160, March, 1947.

That cases of sarcoidosis of the ocular area can be associated with keratoconjunctivitis sicca has already been established.

A 42-year-old woman is described who had been treated for dryness of the eyes for over three years. X-ray studies of her chest showed marked sarcoidosis; then biopsies of the lacrimal glands and conjunctiva demonstrated sarcoidosis. Had the generalized sarcoidosis not been discovered, the keratoconjunctivitis sicca could have been accepted as part of a typical Sjøgren's syndrome, with which it is frequently associated. It is recommended that biopsies of lacrimal glands and conjunctiva be made when the cause of the keratoconjunctivitis sicca is in doubt. (6 figures, 23 references) Morris Kaplan.

Schweitzer, N. M. J. **Spontaneous cavity formation in the cornea in keratoconus.** Ophthalmologica **132**:333, Nov., 1956.

During a phase of acute hydrops a 20-year-old woman with bilateral keratoconus developed a multilocular fluid-filled cavity in the apical portion of her right cornea. On palliative treatment the hydrops and the cavity disappeared within two months, leaving only a slight scar in their wake. Peter C. Kronfeld.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Pillat, A. and Thalhammer, O. **Focal iridocyclitis as the only sign of acquired toxoplasmosis.** Arch. f. Ophth. **158**:403-415, 1957.

The authors describe the clinical picture of an acute focal iridocyclitis in a boy, 11 years old. They reach the diagnosis "acquired toxoplasmosis" with the help of serologic studies and transmission of removed tissue to mice, and summarize their study as follows. This is the first case of acquired toxoplasmotic iridocyclitis with sufficient diagnostic laboratory proof. The use of the Sabin-Feldman test and the skin test permits a faster diagnosis of the age of the condition than any other method. It is not justified to assume

that the Sabin-Feldman test and the complement fixation test identify two different kinds of antibody. Reference is made to A. B. Sabin: Toxoplasmosis. Am. J. Trop. Med. and Hyg. 2:360. (1953). (2 figures, 1 table, 61 references)

Ernst Schmerl.

Velzeboer, C. M. J. **Spontaneous detachment of the choroid.** Ophthalmologica **132**:320-321, Nov. 1956.

A patient with rheumatoid arthritis was given gold therapy for about 10 years without showing any of the well-known toxic reactions; he then developed a unilateral choroidal detachment which resisted various forms of local and systemic treatment and subsided spontaneously after a duration of 11 months.

Peter C. Kronfeld.

Winkelman, J. E. **Essential iris atrophy and glaucoma.** Ophthalmologica **132**:342-344, Nov., 1956.

The iris atrophy present in this 78-year-old man was of the type that causes multiple defects or holes in the stroma layer which slowly increase in size and finally coalesce. The posterior layers of the iris are not affected nor are position and size of the pupil changed (cfr. van Beuningen, Atlas of Slitlamp Gonioscopy, figures 46 and 47). In the case under discussion the iris atrophy was bilateral and gave rise to a subacute glaucoma in one eye, requiring and responding favorably to corneoscleral trephining. (2 figures)

Peter C. Kronfeld.

9

GLAUCOMA AND OCULAR TENSION

Bain, W. E. S. **The fellow eye in acute closed-angle glaucoma.** Brit. J. Ophth. **41**:193-199, April, 1957.

Two hundred patients, 27 to 87 years of age, and who had had an acute attack of closed-angle glaucoma have been followed to observe the fate of the fellow eye. Despite miotic therapy 53 percent developed symptoms in the fellow eye four to 25 years later and 35 percent of these had a typical acute attack. Provocative tests are advised since many of these patients have no symptoms. Peripheral iridectomy is strongly advised as the safest as well as most efficient procedure in properly selected patients. (7 tables, 9 references)

Lawrence L. Garner.

Belfort Mattos, Rubens. **Basic principles of primary glaucoma.** Arq. brasil. de oftal. **19**:147-158, 1956.

Primary glaucoma is found in from 1 to 2 percent of patients. The incidence increases with age, and is slightly more prevalent in women. A family history of glaucoma may be obtained in 10 percent of cases. Refraction plays a role, particularly in narrow-angle glaucoma, where 80 percent of the patients were hypermetropic. Simple glaucoma has few early symptoms. Visual disturbances, difficulty in reading, changes in refraction and visual field defects are those mainly observed. Headache, haloes around lights and pain are not prominent symptoms. Narrow-angle glaucoma presents signs and symptoms which permit diagnosis much more readily. The patient notices haloes around lights as the first symptom in 61 percent of cases. Blurring of vision and loss of accommodation are noticed in young patients. Headache, ocular pain and a feeling of heaviness may be observed, caused in many instances by emotional tension. In the acute phase there are intense pain, loss of vision, nausea and vomiting. This will be bilateral within one year in 70 percent of patients.

Tonometry is an essential part of the evaluation of glaucoma. There are diurnal variations in tension; a variation of 5 mm. is normal. Tonography is of value in determining the facility of outflow. Provocative tests are valuable in early cases or

when the diagnosis is suspected but the tension is normal. Ophthalmoscopy will show three glaucomatous changes, cupping and atrophy of the papilla, choroidal atrophy and arterial pulsation. This latter occurs when the intraocular pressure exceeds the arterial diastolic pressure. Gonioscopy allows observation of the iridocorneal angle, and the determination of the presence of peripheral anterior synechiae, differentiating open-angle from narrow-angle glaucoma. Examination of both peripheral and central fields is essential. It should be emphasized that a patient may retain central acuity for quite some time even though gradually losing his peripheral field, which may be reduced to tabular vision of 10 degrees. (16 references) James W. Brennan.

Cunha, Rubem. **Congenital glaucoma.** Arq. brasil. de oftal 19:193-203, 1956.

Congenital glaucoma is a type of ocular hypertension which occurs in the first years of life and is associated with distention of the globe. This discussion concerns hydrophthalmos, although brief mention is made of the glaucoma associated with aniridia, microcornea, angiomatosis and neurofibromatosis. Hydrophthalmos, or buphthalmos, is generally known as congenital glaucoma. It is a rare affliction, with an incidence of 0.03 to 0.079 percent; males are affected more frequently and both eyes are abnormal in two thirds of the cases. It is generally accepted that it is caused by persistence of mesodermal tissue covering the trabecular spaces. This has been disputed, however, in the belief that this observed tissue represents the uveal portion of the trabeculae, and that an abnormal insertion of the iris contributes to the trabecular impermeability. A hereditary factor may be present also; there is frequent coexistence of congenital heart disease, mental deficiency, pyloric stenosis and renal pathology.

The initial symptoms are photophobia, blepharospasm and lacrimation. Congenital glaucoma should be suspected in any infant with these symptoms which disappear rapidly when the tension is controlled, only to recur with elevation. Classical signs are cloudiness of the cornea, ruptures of Descemet's membrane, increasing size of the globe and a deepening of the anterior chamber. In terminal stages slight trauma may cause severe hemorrhages or perforation of the globe. Tonometry should be done under deep anesthesia. False readings of the tonometer may be obtained if the plane of anesthesia is too light. Gonioscopy should be done to study the angle and observe the presence of the embryonic tissue in the angle.

Included in the differential diagnosis are megalocornea, high myopia, Hurler's disease and congenital idiopathic edema of the cornea. Of lesser importance are anterior staphyloma, kerectasia and keratoconus. Pathologic examination reveals distention of the globe, corneal opacification with ruptures of Descemet's membrane and the endothelium, peripheral anterior synechiae, persistence of the mesodermal tissue in the angle and anomalies of the canal of Schlemm. Degenerative changes are also observed throughout the globe. Treatment is surgical, with goniotomy the operation of choice. Goniopuncture may be employed when this fails or in the later stages of the disease. Cyclodiathermy alone or combined with cyclodialysis is advised by some authors in the later stages of the disease, in an effort to delay complete blindness as long as possible. (16 references)

James W. Brennan.

De Almeida, Antonio. **Surgical treatment of glaucoma.** Arq. brasil. de oftal. 19:165-192, 1956.

Increased ocular tension is but one manifestation of the glaucoma syndrome, and it is against this phase that

surgery is directed. Operative procedures are estimated to be about 80 percent effective in controlling tension and conserving vision. Medical therapy can not produce the same results. Loss of visual field and the appearance of the papilla are of great importance in making a decision to operate. Other factors are inability to control the patient medically, inability of the patient to use medication or to follow instructions adequately. Surgical procedures fall into three categories: those which 1. reëstablish normal drainage channels, 2. the creation of new passages, and 3. diminish the production of aqueous. In any event, careful attention should be given to the preoperative preparation of the patient, sedation, akinesia, and anesthesia.

Illustrations show various techniques, among which is a multiple peripheral iridectomy recommended in subacute narrow-angle glaucoma. The iridectomies are placed at 9-, 12-, and 3-o'clock, and may be done in stages. The author has no preference between iridencleisis and trephination unless lens opacities are present. In this event, he prefers trephination, as a subsequent cataract extraction is technically easier. This is done with an inferior keratotomy and basal iridectomy. Iridectomy is reserved for acute glaucoma of less than 48 hours duration and should be preceded by the administration of diamox to reduce the degree of congestion. Iridencleisis and Elliot's trephine are preferred for primary simple glaucoma, while cyclodialysis is used in the secondary glaucoma in aphakia. (31 figures, 9 references)

James W. Brennan.

De Arruda Novaes, Armando. **Treatment of glaucoma.** Arq. brasil. de oftal. 19:159-164, 1956.

The etiology of primary glaucoma continues to be obscure, with no drug available which will cure the disease. Therapy is designed to relieve symptoms and control the ocular tension. The discovery of diamox has been a valuable adjunct in treating glaucoma, although its mode of action is not perfectly understood. It probably decreases the secretion of aqueous, thus effecting a reduction in tension, although it has been shown to decrease edema of the iridocorneal angle. Simultaneous administration of miotics is indicated. In the event that acidosis develops, the eye may become refractory to the drug. Pilocarpine, eserine, prostigmine and DFP are the recommended miotics, administered in as weak a concentration as possible to control the tension. Cortisone is used only in glaucoma secondary to uveitis. Dibenamine has been effective in narrow angle glaucoma, although it has serious side effects. The importance of early diagnosis of primary glaucoma is stressed.

James W. Brennan.

De Toledo, Renato. **Classification of glaucoma.** Arq. brasil. de oftal. 19:143-146, 1956.

Glaucoma may be classified in general as primary, secondary, and congenital or infantile. Secondary glaucoma is that increase in tension which results from some preëxisting ocular condition. The classical primary glaucoma terminology (primary simple, acute congestive, and chronic congestive) ignores the pathogenesis and should be abandoned. Closed-angle glaucoma (not narrow-angle) should be substituted for congestive glaucoma. The term "open angle" is preferable to "wide angle" but the retention of "simple glaucoma" is suggested, since the type of angle is of no importance in the etiology in this particular type of glaucoma.

Tonography and studies with fluorescein have shown that in acute glaucoma drainage of aqueous is impaired, with disappearance of the difficulty when in remission. In chronic congestive glaucoma, the drainage is related to the state of the angle. In chronic simple glaucoma there

is an increased resistance to drainage, regardless of the phase of the disease. Here, the angle is usually wide, but may be narrow. The author feels that, therefore, the terminology should not emphasize the role of the chamber angle in the genesis of glaucoma. A plea is made for agreement in the adoption of a universal classification. James W. Brennan.

Foulds, Wallace S. **Observations on the darkroom test and its mechanism.** Brit. J. Ophth. 41:200-207. April, 1957.

The analysis is based upon findings in 58 normal and 108 closed-angle glaucoma patients. The tension was taken before and after a one-hour stay in a dark room. A small rise in tension was noted in 36 percent of the normal patients and a small drop in 9 percent of this group. A rise of 8.5 mm. Hg was considered statistically significant and a positive result. On this basis only 51.9 percent of the known closed-angle glaucoma patients presented a positive darkroom test. The greatest percentage of darkroom-positive tests occurred in patients whose initial tension was 26 to 28 mm. Hg. The magnitude of the rise in tension was also greatest in this group. In a few instances a negative test was converted to a decided positive by permitting the patient to remain in the dark for two hours. Outflow tests revealed a definite impairment of flow in subjects whose tension was above 25 mm. Hg, which suggests that angle obstruction of some degree does exist despite a tension that may still be at the accepted norm. The rise in normal eyes, although a small one, is explained as the result of a change in volume of blood in the uvea or rate of aqueous inflow. (3 figures, 3 tables, 13 references) Lawrence L. Garner.

Foulds, W. S. and Phillips, C. L. **Some observations on chronic closed-angle glaucoma.** Brit. J. Ophth. 41:208-213, April, 1957.

Three cases are presented to show that chronic closed-angle glaucoma, with associated field loss and cupping of the discs may be caused by iridocorneal contact and be successfully treated by peripheral iridectomy. The presence of goniosynechiae is probable in such eyes. A peripheral iridectomy in these cases was followed by an immediate increase of depth in the chamber and improvement of tension and outflow rate to well within normal limits. The use of the gonioscope here is not of much help since a very shallow angle makes it impossible to discriminate between iridocorneal contact and goniosynechiae. It is wise to perform the iridectomy away from the 12-o'clock position because further surgery may be required. (5 figures, 4 references)

Lawrence L. Garner.

Hodgson, T. H. and MacDonald, R. K. **Corneo-scleral tonography.** Brit. J. Ophth. 41:301-308, May, 1957.

Eyes were subjected to both corneal and scleral pressure by the electric tonometer in carefully measured and recorded tests. The lowering effect of the pressure on the ocular tension was easily demonstrated and it was borne out that in glaucomatous eyes the fall in tension is appreciably less. In cases of closed-angle glaucoma, even in interval stages, the reaction puts the eyes in the glaucoma group. It was also noted that in so-called low pressure glaucoma with or without field loss, the pressure reaction was glaucomatous. (9 figures, 6 references)

Morris Kaplan.

Krasnov, M. **The mechanism of changes in the intraocular pressure in compression of the eye.** Vestnik oftal. 2:40-47, March-April, 1957.

During the years 1952 to 1955 a study was made on 280 eyes of 153 patients. Krasnov now offers a new principle of evaluation of the rate of compression

lowering of the ophthalmotonus by relative calculation as to what degree the compression lowering compensates for the preceding increase of the intraocular pressure which appears at the time of pressure on the eyeball.

For the study of the causes of the decrease of the compression lowering of the intraocular pressures, the author made four series of experiments on the eyes of 33 rabbits. In all, 92 experiments were carried out to study 1. the pre- and postlethal changes of the ocular tension in combination with compression-tonometric examination, and 2. changes in the reaction of the ophthalmotonus to compression in artificially caused changes in the regulation of the ocular tension, such as the ligation of the vorticose veins, the blockade of the anterior paths of the outflow of the aqueous and reactive hypertension. The experiments are described in great detail. The results suggest that 1. the lowering of the ophthalmotonus by external pressure on the eyeball (compression decrease) is caused chiefly by the decrease of the quantity of blood in the vessels of the uveal tract, and 2. the reaction of the ophthalmotonus to compression of the eye in primary glaucoma can be explained by increased blood supply of the uveal vessels with their resulting local increased blood pressure. These results were obtained by employing a series of new methods: 1. the compression-tonometric study on human eyes, 2. the compression-tonometric investigation on animal eyes and 3. the study of the intensity of the flow of the blood in the vorticose veins in animal eyes. (5 tables)

Olga Sitchevska.

Nakaji, H. **Effect of convulsive shocks on ocular tension.** Acta Soc. Ophth. Japan **61**:5-8 and 548-561, Jan. and May, 1957.

This is a study of the ocular changes in rabbits by shock induced by electric stimuli, cardiazole and insulin. The change in the ocular tension was followed by tonometry, and that of the aqueous circulation by fluorescein tests. The shock was given repeatedly every day. In a few days a lowering in ocular tension began to appear which was followed by a recovery of the original tension or even by an increase in tension during the next few weeks. Finally continuous hypotension resulted. During the stages of hypotension there was choroidal anemia and a delay in the production of aqueous; the converse was true in the stage of hypertension. In the stage of the continuous hypotension, some nonspecific choroidal lesions appeared, such as an appearance of vesicular structure in the choroidal vein and choroidal hemorrhages. Nakaji tries to explain the changes by the stress theory of Selye. Finally, he tries to explain the developmental mechanism of glaucoma, epithelial keratitis and central serous retinopathy by an adaptation syndrome. (6 figures, 2 tables, 39 references)

Yukihiko Mitsui.

Niemeyer, Waldemar. **Secondary glaucoma.** Arq. brasil. de oftal. **19**:204-218, 1956.

Secondary glaucoma, in contrast to primary glaucoma, is that in which the increased ocular tension results from a known cause. It is conceivable that as our knowledge increases the group of secondary glaucomas will increase with a corresponding decrease in the "primary" or idiopathic group. The author classifies secondary glaucoma as 1. traumatic: contusions, perforating wounds, intraocular surgery, delayed onset after corneal fistula, and adherent leukoma, 2. inflammatory: uveitis, rubeosis iridis, herpes zoster, and corneal ulcer, 3. vascular: thrombosis of the central retinal vein, hemorrhages, congenital vascular anomalies of the retina, 4. neoplastic: intraocular or extraocular tumors, 5. degenerative diseases: essential atrophy of the iris, in-

tumescent cataract, glaucoma capsulare and angiomatosis, 6. congenital anomalies: ectopia lentis, retrolental fibroplasia, aniridia, 7. peribulbar conditions: orbital cellulitis and tenonitis, 8. detachment of the retina, and 9. experimental glaucoma (rabbits): ligature of vortex veins, injection of irritating substances.

Treatment varies with the cause of the hypertension, and when directed against the tension is merely symptomatic. Most valuable in recent years has been the administration of diamox. Therapeutic use of X rays has been effective in treating uveitis and the glaucoma which may complicate it. Surgical therapy should be individualized according to the indications. A thorough examination which includes precise tonometry, gonioscopy and a study of the aqueous veins is necessary to evaluate the condition, and will also contribute to our knowledge of primary glaucoma. (33 references)

James W. Brennan.

Valgarce, Joaquin. **The pathologic anatomy of glaucoma.** Arch. Soc. oftal. hispano-am. **16**:1288-1309, Dec., 1956.

This is a review of the literature, based chiefly on the lectures on glaucoma at the Harvard postgraduate course of ophthalmology in 1955. (20 figures, 4 references) Ray K. Daily.

10
CRYSTALLINE LENS

Emmrich, K. **Correction of aphakia with artificial anterior chamber lenses.** Arch. f. Ophth. **158**:502-505, 1957.

The author states that recently more ophthalmologists try to correct aphakia with lenses implanted into the anterior chamber. He presents the geometric optical conditions produced by the Strampelli lens made from polymethacrylate and having an index of refraction of 1.492. For the calculations the original paper should be consulted. (3 figures, 2 references)

Ernst Schmerl.

Merriam, G. R., Jr. and Focht, E. F. **Clinical study of radiation cataracts and the relationship to dose.** Am. J. Roent. 77:759-785, May, 1957.

Stray irradiation from treatment of tumors about the head and neck caused cataract in 100 cases and failed to cause the expected cataract in 73 cases reported from the Head and Neck Service, Memorial Center, N.Y. To measure the exact dosage received by the lens in each case, a phantom skull was devised. For instance, a tumor of the nasopharnyx was irradiated for a certain time from a certain direction, with a given kilovolt source through a given shielding. In the position of the lens, the irradiation was measured by an ionization chamber method, when the phantom skull was given the duplication treatment.

Patients receiving one dose of irradiation in which the lens dosage was less than 175 r did not develop cataract. Those lenses receiving more than 200 r all developed at least minimal cataractous changes. If the irradiation was given in divided doses over a three months period, as much as 400 r did not cause cataract, but 43 patients developed cataract who received between 550 and 6900 r. In one case, 11 years passed before the cataract developed, and in many cases, it required five years.

Cataracts developing after one irradiation came on within months. Divided dosage delays the onset and the degree of progress toward maturity of the cataract. Many slight irradiation cataracts are never detected. Of lenses receiving 750 to 950 r within three weeks to three months, 60 percent will become cataractous, and of these 50 percent will become mature. All patients receiving more than 1150 r to the lens developed cataract. Patients

under the age of one year are much more radiation sensitive. Paul W. Miles.

de Saint Martin, R. **The usual causes of hyphemas following cataract extraction.** Ophthalmologica **132**:345-364, Dec., 1956.

The literature on hemorrhages into the anterior chamber following cataract operations (PCH, post-cataract-hemorrhages) is reviewed, starting with de Wecker's treatise of 1886 and ending with the recent studies by Dubois-Poulsen (1950), Sedan (1951) and Malbran (1953). Saint Martin then analyzes a series of 1,613 cataract operations of his own for possible causes of PCH. He divides this series into three groups or periods: 1. the period from 1935 to 1948 during which he practiced limbic incisions, mostly conjunctival sutures and "less meticulous postoperative care," 2. the period from 1948 to 1950 during which he used corneoscleral sutures and strictly corneal incisions and 3. the period from 1950 to 1953 characterized by the addition of more careful, more individualizing preoperative, operative and postoperative medical care. This included more careful preparation of the hypertensive and the diabetic patient, deeper or more lasting topical anesthesia, profound hypotony during the operation and again, individualizing postoperative care. The incidence of PCH in the three periods has been 11, 7 and 2 percent respectively. Saint Martin concludes that the very large majority of PCH are due to trauma, in the sense of direct contusion, brusque lid pressure or active or passive congestion of the head, and originate in the region of the operative incision. Truly spontaneous PCH are very rare; their causes are not definitely known but may be largely systemic and not related to the operative technique. The incidence of the traumatic PCH should continue to become less and less because of wider adoption and more efficient practice of the principles of 1. proper preoperative treatment of cataract patients with vascular diseases, 2. prolonged akinesia, and 3. ocular hypotony maintained during the entire operation. (33 references)

Peter C. Kronfeld.

Stanković, I. and Kecmanović, Z. **Megalocornea and cataract.** Ann. d'ocul. **190**:36-42, Jan., 1957.

A brief review of the characteristic findings in anterior megalophthalmos is given. All the published cases (30) were collected, and the authors add two of their own. The overall success rate for cataract extraction in these cases is about 65 percent with a loss of vitreous reported in 40 percent. The authors feel that these figures can be improved by use of a corneal incision, multiple corneoscleral sutures, a peripheral iridectomy and insufflation of air into the anterior chamber after surgery. (17 references) David Shoch.

11

RETINA AND VITREOUS

Bokunyaeva, A., Laikhter, B., Lev, R. and Neiman, V. **The aged and degeneration in the macular region.** Vestnik oftal. **2**:36-39, March-April, 1957.

The authors examined 62 patients, from 50 to more than 70 years of age, in whom macular degeneration was diagnosed. The vague initial symptoms, the ophthalmoscopic picture and the course of the disease are described in detail. In 16 patients the vision was impaired in both eyes, in 28 in one eye and in 12 there was no impairment of vision. Most of the patients had atherosclerosis, cardiac and hypertensive diseases. The classical senile degeneration was found in 46 patients. In some the diagnosis was missed because they had glaucoma and the pupils could not be dilated. The disciform degeneration was observed in two, colloidal in four and retinitis circinata in three patients. The

disciform degeneration is the most severe as it is the result of a hemorrhage; changes are localized between the lamina vitrea and the neuroepithelium. First a transudate penetrates the pigment epithelium and spreads to the neuroepithelium; later connective tissue forms with subsequent degeneration of the remaining layers of the retina. The initial changes in the macula are best seen with red-free light. Amsler's chart was also used for diagnosis. The authors stress the importance of early diagnosis since active oxygen therapy acts favorably on the course of the disease (usually the sclerosis of the vessels indicate oxygen deficiency). Vasodilators, tissue therapy and iodides also were used with good results in some patients. (1 drawing) Olga Sitchevska.

Donders, P. C. **Treatment of Eales' disease by electrocoagulation: a preliminary report.** Ophthalmologica **132**:334-337, Nov., 1956.

Weve in his Bowman lecture (1939) pointed out the possibility of treating Eales' disease by electrocoagulation aimed at diseased retinal vessels. The present writer has attempted to make a follow-up study of 23 cases of Eales' disease treated with diathermy in Utrecht since 1939. Only 10 cases have been observed for one or more years. Four of these have shown no recurrence. Five have developed recurrences; four of these have been coagulated again with good results in three. In one patient a severe intravitreal hemorrhage occurred after the first operation, in another patient after the second operation. The author considers the results as being good in seven of the 10 cases. He recommends that the operation be restricted to cases in which only a few vessels are affected. He advises against trying electrocoagulation in patients with very extensive lesions and secondary retinal detachment. (4 figures, 11 references)
Peter C. Kronfeld.

Gareis, R. and Platzer, F. **Audiometric studies in tapetoretinal degeneration.** Arch. f. Ophth. **158**:462-467, 1957.

In a number of conditions eye and ear are simultaneously involved. The authors studied the hearing of 16 patients with tapetoretinal degeneration. The patients' age varied from 8 to 49 years. Their audiometric curves were compared with normal curves obtained from people of the same age, and 50 percent of the patients showed diminished hearing. Corti's organ or the cochlear nerve seemed to be affected. Patients with inflammatory fundus changes showed normal audiograms. (3 figures, 1 table, 15 references) Ernst Schmerl.

Matteucci, Pellegrino. **Ophthalmological study of a variety of retinal changes of a degenerative nature.** Rassegna ital. d'ottal. **25**:321-332, Sept.-Oct., 1956.

Biomicroscopic study of the fundus reveals interesting details of the morphology and the seat of certain degenerative foci. The opaque, white, roundish opacities appear behind the retina and spread into the external layers. The irregular yellowish foci have their seat in the choroid, are transparent with scintillating golden borders and are drusen of the lamina vitrea. On the other hand verrucae of a hyaline nature may undergo calcification and become difficult to differentiate. Six cases are described and illustrated by colored photographs. (4 figures, 30 references)
E. M. Blake.

Meyer-Schwickerath, G. and Sampaolesi, R. **Photocoagulation in the treatment and prevention of retinal detachment.** Arch. oftal. Buenos Aires **31**:331-336, Dec., 1956.

When concentrated in a narrow beam and focused upon the fundus, the light from a carbon-arc lamp may be used to coagulate circumscribed areas of the choroid and the retina (cf. Meyer-Schwickerath, G. Acta XVII Conc.

Ophth., 1954, vol. 1, p. 404). Holes at the posterior pole may be successfully sealed in this way under direct visual control, as may also some peripheral tears when the retina is not markedly detached at their level. Small tumors, such as malignant melanomata of the choroid or the iris and retinal angiomata, have shown no recurrence after having been destroyed with this procedure. In retinal periphlebitis, vitreous hemorrhages can be stopped when the bleeding vessels are obliterated in this manner. Although the method is undoubtedly promising and its rationale sound, the exceedingly high cost of the instrument used as a light source—the heliocauter—will, for the time being, make wide use difficult.

A. Urrets-Zavalia, Jr.

Williams, I. G. **Radiation therapy in the treatment of retinoblastoma.** Am. J. Roent. 77:786-795, May, 1957.

This article for roentgenologists concerns the nature and treatment of retinoblastoma. Irradiation enough to damage the tumor will also damage the retina, lens, and uveal tract. In a series of 36 patients treated by Stallard, several were given radon seeds or X-ray irradiation. The best results were in the 29 patients treated by radio-cobalt disc, the design and the use of which are described in detail. Of these, 28 were cured, 20 have at present good vision, and 7 have survived five years. Paul W. Miles.

12

OPTIC NERVE AND CHIASM

Martin, V. A. F. and Schofield, P. B. **Meningioma invading the optic nerve.** Brit. J. Ophth. 41:161-166, March, 1957.

Meningioma of the optic nerve is not altogether rare and usually occurs after the first decade of life and most frequently after the age of 30 years. Invasion of the optic nerve itself is rare and the occurrence of the primary site of the tumor within the orbit is likewise rare. The authors describe a meningioma in a three-year-old boy. The tumor was seen in the fundus and the eye was enucleated. The tumor was found to have invaded the optic nerve, the central retinal vessels, the optic disc, choroid and retina and may well have been primary within the orbit. (5 figures, 14 references)

Morris Kaplan.

Wenda, L. **Retrobulbar neuritis as an allergic disease.** Arch. d'opht. 17:44-46, 1957.

The author notes the lack of exact information on the etiology of retrobulbar neuritis and reviews current theories. He advances allergy as an important cause and cites a case of a young girl in whom allergy of infection (tuberculosis) seemed to play a role. Treatment with streptomycin and P.A.S. led to rapid cure with return of full vision and fields. He mentions the difficulties encountered in determining specific sensitizations.

P. Thygeson.

13

NEURO-OPHTHALMOLOGY

Hiroishi, M. and Kawaoka, H. **A new conception of the entity of fixatory pseudonystagmus.** Acta Soc. Ophth. Japan 61:327-332, April, 1957.

The authors analyze the nature of fixatory pseudonystagmus. This movement was recorded by an oscillograph through a pick up. The movement was a vibration of 10 cycles per second. A similar vibration was demonstrated in the cat's eye and in other skeletal muscles of man. They conclude that the nystagmus is merely a kind of microvibration of the system and is not specific for the fixation of the visual line. (5 figures, 7 references)

Yukihiko Mitsui.

Jain, N. S. **Synkinetic lid retraction.** Brit. J. Ophth. **41**:247-253, April, 1957.

Nine cases of abnormal retraction of the lid are reported; four of these were congenital. The others were due to subarachnoid hemorrhage, typhoid, syphilis, myasthenia gravis and head injury. (9 figures, 1 table, 1 reference)

Lawrence L. Garner.

Ohm, J. **The basic concepts of optokinetic nystagmus.** Arch. f. Ophth. **158**: 485-494, 1957.

This is a summary of some of the former studies of this author. (3 figures, 2 tables, 14 references) Ernst Schmerl.

14

EYEBALL, ORBIT, SINUSES

Malhotra, Manmohan. **Orbital cellulitis with exudative retinal detachment.** Brit. J. Ophth. **41**:317-319, May, 1957.

Exudative detachment of the retina in orbital cellulitis is rare and is due to venous congestion and edema across the fibrous sclera. The detachment is not severe since there is no tear and the treatment is the treatment of the cellulitis. A 12-year-old boy is briefly described who had detachment of this kind with complete cure when the cellulitis subsided. (1 figure, 9 references) Morris Kaplan.

15

EYELIDS, LACRIMAL APPARATUS

Burch Barraquer, Manuel. **The technique and advantage of subperiosteal trepanation in dacryocystorhinostomy.** Arch. Soc. oftal. hispano-am. **16**:1219-1226, Nov., 1956.

The author, who has written extensively on this subject, points out the advantage of separating the periosteum along with the overlying tissues from the bone before trephining an opening into the nose. The separation of the periosteum frees the bone from its vascular supply and provides a dry field. After the usual incision and separation of the periosteum, the lips of the wound are separated by a specially designed separator with two arms of different lengths; the nasal arm is 9 mm. in length, and the external arm, which holds away the separated periosteum and the overlying tissues, is 14 mm. long. The trepanation into the nose, the formation of the flaps, and the suture of the anterior and posterior flaps is done in the usual manner; the author believes that the suturing in two planes provides a more effective hemostasis. (6 figures) Ray K. Daily.

Cavka, V. **Bridge flaps for the replacement of the lower lid.** Ophthalmologica **132**:271-277, Oct., 1956.

For the reconstruction of lower lids destroyed by tumors, trauma or inflammatory disease, the author uses bridge flaps from above the eyebrow, with a fairly broad glabellar as well as a temporal base. (6 figures) Peter C. Kronfeld.

Fanta, H. **Plastic operation of an epithelioma of the inner canthus.** Klin. Monatsbl. f. Augenh. **130**:389-391, 1957.

The author advises a full thickness graft from the upper lid. The result was good in six patients. (1 figure, 5 references) Frederick C. Blodi.

Taylor, Charles. **Accidental vaccinia.** Brit. J. Ophth. **41**:243-246, April, 1957.

Vaccinia occurred in a young mother whose infant had been vaccinated thirteen days before. Treatment by means of antibiotics and ascorbic acid and, in the resistant cases, vaccinia-immune serum or vaccinia gamma-globulin is recommended. (4 figures, 1 table, 11 references)

Lawrence L. Garner.

16

TUMORS

Greer, C. H. **The pathology of intra-orbital tumours.** Tr. Ophth. Soc. Australia **16**:139, 1956.

The relative incidence of primary and secondary tumors in the extraocular

orbit is briefly reviewed and the pathology of the commoner primary tumors is described with special reference to the clinical manifestations of their natural evolution. The main groups are hemangiomata, chronic granulomata, lymphomatous tumors, meningiomata, gliomata, tumors of peripheral nerves, dermoid cysts and tumors of the lachrymal gland. Ronald Lowe.

Lidgett, K. **Recurrent malignant melanoma in the orbit: report of a case.** Tr. Ophth. Soc. Australia **16**:151, 1956.

The clinical and pathological findings are reported in a case of a malignant melanoma of the choroid recurring in the orbit 14 years after enucleation. Exenteration of the orbit is justified in such a case even though the ultimate outlook is poor. Ronald Lowe.

Rodenhaeuser, Joe Henry. **Molluscum pseudocarcinosum (molluscum sebaceum, keratoacanthoma).** Arch. f. Ophth. **158**: 468-484, 1957.

The findings of this study are practically the same as those described by G. Hager in the foregoing number of the Archiv. (10 figures, 21 references) Ernst Schmerl.

Scassellati Sforzolini, Guidobaldo. **Histologic study of choroidal melanoblastomata subjected to transscleral diathermy coagulation.** Rassegna ital. d'ottal. **25**: 333-356, Sept.-Oct., 1956.

This subject dates back to 1930 when Weve first reported upon several cases. The literature from that time to the present is reviewed. The author describes three cases of choroidal melanoblastomata treated by diathermy coagulation and studied microscopically to confirm the diagnosis. Complete studies were done to determine whether it was the action of heat or of toxins produced by injured cells. Profound structural changes in the cells occurred but the temperature which the globe could tolerate left masses of neoplastic tissue. The treatment described should be restricted to cases where enucleation is denied. There remains also the question of the accuracy of diagnosis in some recorded recoveries. (9 figures, 20 references) E. M. Blake.

Trevor-Roper, P. D. **Intra-epithelial epithelioma. (Bowen's disease).** Brit. J. Ophth. **41**:167-173, March, 1957.

Bowen's disease is a precancerous lesion of the epithelial structures of the eye; it may occur on the cornea, conjunctiva or eyelid, generally of elderly men. At first it is seen as an elevated plaque which may remain unchanged for years then break through its basement membrane as a definite cancerous lesion which gives rise to distant metastases. If this lesion is recognized early when it yields easily to treatment by removal or to beta irradiation, lives and eyes may be saved. One case in a 77-year-old man is described in detail. The lesion was noticed early and removal was followed by exposure to strontium. Healing was uneventful. Seven cases from the files are described briefly. (8 figures, 9 references) Morris Kaplan.

17
INJURIES

Bonhoure, C. **Some observations on penetrating wounds of the ocular globe.** Arch. d'opht. **16**:707-723, 1956.

Bonhoure notes that traumatic lesions of the globe have been the subject of numerous reports but that very little new has been added so far as treatment is concerned. He notes that antibiotic therapy has saved many globes which might otherwise have been lost but that the visual results in retained globes have not been materially altered. He then discusses the influence of the penetrating agent and of the damage to the lens, iris, ciliary body, and vitreous on the final result, but concentrates his major attention on the corneal and scleral problem. He offers three series of observations on severe penetrat-

ing injuries treated effectively by tissue transplants. He feels that in these cases the eyes would have been lost if conventional methods had been used. On the basis of his experience with these and other cases, he advocates immediate excision of badly damaged corneal and scleral tissues and replacement with grafts. He believes that future research should be directed along these lines.

P. Thygeson.

Haik, G. M. **The treatment of injuries to the eye.** Chicago Med. Soc., Clin. Conf. pp. 37-44, July, 1956.

Physicians not specially trained in ophthalmology are advised to avoid the definitive treatment of eye injuries except in mass disasters, certain industrial calamities, and in completely inaccessible areas. The dangers of unskilled interference are vividly portrayed. General first aid measures are outlined, and then injuries are dealt with in their appropriate classes: lid lacerations, contusions of the globe, corneal abrasions, perforations, foreign bodies, and burns. The generally accepted first aid measures for each of these groups and their sub-groups is lucidly outlined.

Harry Horwich.

Holmes, W. J. **The management of intraocular foreign bodies.** Tr. Ophth. Soc. Australia **16**:93, 1956.

This paper presents a comprehensive general account of the subject without any statistics. The author favours the anterior route for extraction of magnetic foreign bodies and describes the use of the Thorpe endoscope for removal of nonmagnetic foreign bodies. Retinal detachment must be prevented or promptly treated. Removal of an injured eye is only indicated when it is collapsed through extensive loss of vitreous and when light perception has gone. Ronald Lowe.

McCulloch, Clement. **Ocular disease and injury in the event of national emergency.** Canad. M. A. J. **76**:381-385, March 1, 1957.

In a national emergency nearly all eye patients should be evacuated. Hospitals will be moved. In patients requiring immobilization, eyes should be bandaged, and the patients moved on a stretcher. Atomic bomb injuries of the eyes are described and the treatment specified. Signs of a penetrating injury are described so that the first-aid man will know when to call for an ophthalmologist. (2 tables)

Paul W. Miles.

Moore, M. C. **Ocular injury from electric current and lightning flash.** Tr. Ophth. Soc. Australia **16**:87, 1957.

Three cases are described showing permanent paracentral scotomas after electrocution by 220 or 440 volts. Two cases were unilateral and the homolateral pupil was smaller than the unaffected side. Four persons showed reduced vision due to macular lesions following exposure to close lightning flashes.

Ronald Lowe.

Pagani, Luciano. **Gonioscopic observation after contusion of the eyeball.** Rassegna ital. d'ottal. **25**:368-373, Sept.-Oct., 1956.

Two cases of trauma to the eye were studied gonioscopically; the early changes and those which occurred five to six months later are described. The writer suggests that this method reveals not only such findings as simple hyphema, minute iridodialysis, holes in the iris or foreign bodies hidden in the angle, but that it is especially valuable in what appear to be very simple injuries. (2 figures, 16 references) E. M. Blake.

Shea, M. **Traumatic hyphaema in children.** Canad. M. A. J. **76**:6, 466-469, Mar. 15, 1957.

The injury is most often caused by missiles, such as BB shot. It is most common in boys from six to twelve years of

age. Secondary hemorrhage usually occurs on the third and fourth day. Glaucoma appears after secondary hemorrhage. The prognosis is good. Treatment consists of bed rest with both eyes bandaged for at least six days. (2 figures, 6 tables, 12 references) Irwin E. Gaynon.

Spaeth, E. B., Thorpe, H. E. and Moore, P. G. **Symposium: foreign bodies.** Tr. Am. Acad. Ophth. 60:688-710, Sept.-Oct., 1956.

Spaeth, Edmund B. **Intraocular magnetic foreign bodies.** pp. 688-693.

Spaeth considers four factors important in the removal of magnetic foreign bodies. The surgeon must adjust his technique to the magnetic quality and size of the foreign object. The size and shape of the foreign body is a definite factor in determining whether the approach should be anterior or posterior. X-ray films usually demonstrate the shape of the foreign body. Most iron and steel particles 10 mm. from the magnet point can be extracted with ease with an ordinary magnet. Spaeth quotes Lancaster's description of a good magnet. The giant magnet permits varied manipulations at different angles for attracting or dislodging a fragment and guiding a metallic particle around the posterior surface of the lens and through the suspensory ligament into the posterior chamber. The ideal situation is to have both hand and giant magnets available, but if only one were obtainable, he would definitely choose the giant magnet. The distance of the magnet from the foreign body is important. The power of the magnet to attract a metallic foreign object diminishes with an increase in the distance between the magnet and the object. If the pulling power of the magnet at 1 mm. is 1 gram, by increasing the distance to 2 mm., the pulling power becomes only ⅛ gram, and at 4 mm. it has dropped to 1/64 of a gram. The most effective magnetic point is one with a blunt tip, as broad as long and pyramidal in shape; the weakest magnetic point is the long, thin one. Spaeth says that the introduction of forceps, probes, and similar instruments is ineffective and dangerous.

It is important to decide whether to use the anterior route or the posterior transscleral route for extraction. In general, the smaller the particle, the greater the indication for the anterior route. An intact lens should be preserved but if it is injured, the anterior approach is indicated for larger fragments also. Particles entering through the posterior segment of the sclera or which lie in the posterior segment of the globe, should be extracted by the anterior route.

If point of entrance is behind ciliary zone and anterior to equator, extraction may be done at the site of entrance. Incision for the extraction should be scleral, as close to the particle as possible, and then the hand magnet used. Sclerotomy incisions should be ringed with diathermy to prevent retinal separation. Extraction of particles suspended in the vitreous requires the use of the giant magnet and should be done early. Particles incarcerated in the ciliary body must be removed through the anterior route from the anterior chamber angle. Particles in the posterior chamber or in the anterior chamber angle may be visualized with the contact glass. (3 figures, 1 reference)

Thorpe, Harvey F. **Intraocular nonmagnetic foreign bodies.** pp. 694-706.

Thorpe discusses intraocular nonmagnetic foreign bodies. This type has increased because of the use of alloys, and it must actually be seen by the surgeon in order to be grasped with an instrument. The evaluation of damage that may be done may influence the management and the likelihood of infection must be considered. The chemically inert splinters may often be left undisturbed. Thorpe stresses an accurate history as to type of

particle and circumstances surrounding the accident as well as the previous eye history as to visual impairment or inequality. Examination both subjectively and objectively of the injured and fellow eye and the adnexae is most important. A complete examination should include bio-microscopy, gonioscopy and transillumination. Perimetry, diagrams and photographs may be helpful for diagnosis and management. X-ray examination should give the exact location, size, and nature of the foreign body and it is helpful to have a roentgenologist who is experienced in meticulous foreign body localization. Seven X-ray methods for localization are described. The Berman locator is extremely valuable especially in differentiating a magnetic from a nonmagnetic foreign body. Procedures for removal of foreign bodies in the anterior and posterior chambers, lens and vitreous are discussed. Two case histories are presented. (16 references)

Moore, Paul G. **Extraocular foreign bodies.** pp. 707-710.

Moore discusses extraocular foreign bodies in a very practical manner, and states that most important is the care of the eye after their removal. He discusses at length the removal of foreign bodies of the cornea, explains the formation of the so-called rust ring, and states his preference for instruments used. He is not averse to leaving an eye uncovered after removal of a corneal foreign body.

Theodore M. Shapira.

Youdegite, O. **Subconjunctival injections of blood in chemical injuries of the eye.** Vestnik oftal. 2:53, March-April, 1957.

After preliminary studies on rabbits the author used daily subconjunctival injections of 2 cc. of fresh blood taken from the patient's vein, from three to five times, in chemical burns of the eye. The observation of 50 such patients since 1949 showed a shorter time of healing and a more transparent cornea than is usually observed after other methods of treatment. The method is simple and can be done in the clinic. Previously, this method was tried out on rabbits. Olga Sitchevska.

18

SYSTEMIC DISEASE AND PARASITES

Budden, F. H. **Natural history of onchocerciasis.** Brit. J. Ophth. 41:214-227, April, 1957.

The results of 43 months of observation are recorded to describe the serious affection of the eyes of patients in a village exposed to heavy endemic onchocerciasis. The ocular lesions are directly related to the concentration and distribution of microfilariae in the body and biopsy of skin from the lower half of the body showed a 100 percent infection rate in those over 19 years of age; 29 percent of those over 40 years of age were blind from this condition. Blindness results from the invasion of the anterior and posterior segments by microfilariae. Corneal opacification, uveitis, secondary glaucoma and choroidoretinal degeneration are common. Treatment by the use of filaricides is recommended for the early or mild cases in mass treatment camps. Therapy is not without risk. (3 tables, 16 references)

Lawrence L. Garner.

Bussinello, E., Bajocchi, E. and Gualdi, G. **Ocular manifestations in the course of leptospirosis.** Rassegna. ital. d'ottal. 25:202-205, May-June, 1956.

The authors studied 32 persons from the rice country and affected with leptospirosis. Examination with the slitlamp showed only five cases with evidence of affection of the iris and ciliary body. This low figure of 15 percent agrees with that of other workers and must be considered in strict relationship to the time of observation and the lessened gravity of the leptospirosis of rice eaters as compared

with that of the icterohemorrhagic form as seen by the slitlamp. (2 tables, 14 references) Eugene M. Blake.

Dern, Philip L. **Amino-aciduria with cystinosis: case report with determination of urinary amino acids and ocular cystine.** Ann. Int. Med. **46**:138-144, Jan., 1957.

A case of Fanconi syndrome with cystinosis in a boy two and one-half years of age is described. He had polyuria, poor growth and an enlarged liver. The urine specific gravity was 1.003. Pyelograms revealed normal kidney structure and size. Slitlamp examination showed numerous fine, superficial crystalline deposits in the conjunctiva and cornea, and in biopsy of the bulbar conjunctiva cystine crystals were found. Blood levels of cystine, arginine and threonine were normal in the child. The patient was treated with milk, vitamin D, sodium citrate and citric acid. He remained very active, but did not improve within six months.

The Fanconi syndrome consists of renal tubular defects in which amino acids are not reabsorbed. Cystinosis has never been reported in adult Fanconi syndrome, but is found in children. Cystine crystals are deposited in the bone marrow, in the eyes, and in reticuloendothelial tissues. In cystinosis, there is disease of the proximal convoluted tubule of the kidney.

The mechanisms of bone disease and amino-aciduria are discussed. The Fanconi syndrome was distinguished from cystinuria and from the Butler-Albright and Lightwood syndromes. (1 table, 42 references) Paul W. Miles.

Frandsen, Emil. **Visual manifestations of digitalis poisoning. Two cases of toxic amblyopia.** Acta Med. Scandinav. **157**:51-59, 1957.

The author points out that digitalis poisoning may affect the papillomacular bundle and give rise to the clinical manifestations of retrobulbar neuritis. This damage may occur a few days or a few years after the beginning of therapy with usual doses of digitalis. The defect is not always preceded by the common manifestations of chromatopsia and flickering. (3 figures, 21 references) Irwin E. Gaynon.

de Gennaro, Giuseppe. **Ocular manifestations of parasitic infestation in man.** Rassegna ital. d'ottal. **25**:288-309, July-Aug., 1956.

The author describes infestation of the eye in man with 1. Acarus, 2. Actinomyces, 3. Ameba, 4. Ancylostoma, 5. Ascaris, 6. Aspergillus, 7. Blastomyces, 8. Cystocercus, 9. Echinococcus, 10. Filaria, 11. Trematode larva, 12. fly larvae and 13. Sporotricum. This list affords an excellent way of making a differential diagnosis in the often rare disease observed in the eye. The illustrations are helpful. (20 figures, 30 references) Eugene M. Blake.

Gray, Leon F. **Tuberculosis; eye.** Louisiana St. M. Soc. **109**:90-93, March, 1957.

If there is a high degree of tissue reactivity to tuberculin, or evidence of acute inflammation in the eye, the sensitivity of the ocular tissues may be assumed to be high. Tuberculin desensitization is indicated in dosage low enough to avoid causing local or focal reactions. "The specific therapy consists of a mixture of streptomycin and dihydrostreptomycin, 1.0 gram every second day; para-aminosalicylic acid, 12 grams daily, and isoniazid, 300 to 150 mg. daily in divided doses. Treatment must be continued for a minimum of 42 days or longer, if a full therapeutic response is not obtained." (12 references) Irwin E. Gaynon.

Hoffmann, D. and Lindquist, B. **Endocrine exophthalmus in a newborn with**

a thyrotoxic mother. Klin. Monatsbl. f. Augenh. **130**:296-304, 1957.

A mother had had a thyroidectomy before she became pregnant and radioactive iodine during pregnancy. The baby showed no other obvious disturbances. (1 figure, 42 references)

Frederick C. Blodi.

Holmes, W. J. **Ocular leprosy.** Tr. Ophth. Soc. Australia **16**:30, 1956.

All parts of the eyes and adnexae may be affected. In the past, severe lesions occurred as a result of lagophthalmos which caused exposure of anesthetic corneas, and uveitis was also common. Since the discovery of the sulphone drugs the incidence and severity of ocular complications have been considerably reduced in cases in which the drugs were administered early and combined whenever necessary with steroids, antibiotics, hormones, vitamins and other forms of treatment. Once an eye lesion develops, sulphone therapy alone will not arrest its progress nor will irreversible changes be overcome. Ronald Lowe.

Kuhn, E. and Piesbergen, H. J. **Hypotony and cataract in myotonic dystrophy.** Klin. Monatsbl. f. Augenh. **130**: 329-335, 1957.

The cataract is not an early sign and six patients with early dystrophy were seen who had clear lenses. The intraocular pressure was low in four, low normal in six, and normal in three patients. There was no correlation between cataract and hypotony. (2 tables, 7 references)

Frederick C. Blodi.

Leonardi, F. **A study of the behavior of the retinal-intracranial circulation in pregnancy and in the puerperium.** Boll. d'ocul. **35**:529-542, Aug., 1956.

The author reviews the literature concerning the effects of pregnancy and the postpartum period on the general and retinal arterial pressure. He then presents the results of his study of 85 women during pregnancy and the puerperium. In most cases there was an increase in the pressure in the retinal-intracranial vascular system during the final stage of pregnancy. During the puerperium a certain degree of hypotension became evident in this same system. (2 tables, 64 references) William C. Caccamise.

Lopez Martin, I. and Gomez Fernandez, L. **Ocula-nasal myiasis caused by bovine oestrus ovis.** Arch. Soc. oftal. hispano-am. **16**:1165-1194, Nov., 1956.

The objective of this paper was to review the nine cases of this disease reported in Spain. The morphology of the various stages of development of the larva of the parasite are described in detail, and the characteristics of the geographic location of the parasite are pointed out. Symptoms of the disease produced by the parasite in sheep and in men are described. The author does not accept the theory that the disease is transmitted through contaminated cheese, but believes that the parasite is attracted by the odor of cheese on the breath of the shepherds. The second stage larva causes sinusitis as well as the sleepiness associated with the disease. (10 figures, 1 table, 48 references) Ray K. Daily.

Mueller, F. **The syndrome of Takayashu.** Ophthalmologica **132**:365-374, Dec., 1956.

A typical case of pulseless disease in a 30-year-old woman could be followed for several years. A dissecting aneurysm of the aortic arch could be demonstrated roentgenographically. During the period of observation cataracts developed and required surgical treatment. The postoperative course was characterized by repeated hemorrhages into the anterior chamber (cf. Am. J. Ophth. 41:741 and 1117, 1956). (3 figures, 30 references)

Peter C. Kronfeld.

Paterson, M. W. **Ocular changes in the pulseless disease (Takayasu's disease): the aortic arch syndrome.** Scottish M. J. **2**:57-65, Feb., 1957.

In bilateral obliteration of the common carotid artery, gradual collateral circulation develops, but not enough to prevent severe symptoms. A patient, aged 25 years, had, as his chief complaint, abnormal fatigue, breathlessness on exertion, left headache, and fainting attacks. The left pulse was weak, and the systolic blood pressure was 30 mm. Hg. The right arm blood pressure was 90/68, but that of the right leg was 210/116. The vision of the right eye was 6/12, left eye 6/9. The margins of the optic disc were blurred, the veins slightly congested. There was slight macular edema. Six months later the vision was reduced to finger counting in one eye and blindness of the other. The optic disc was completely obscured by a mass of new formed vessels, and there was edema of the disc margin. The retinal arterioles appeared normal, the veins were congested with a granular blood column. The blood moved sluggishly and in the periphery merely oscillated. Several soft-edged gray patches were visible in the central area. One eye developed cataract. The patient died within 12 months of the onset.

In early cases patients have complained of "a glittering before the eyes," foggy vision, or "black-outs," usually brought on by exertion. One patient complained of poor vision upon waking, with an altitudinal hemianopia which improved as she became more active. Several patients showed loss of accommodation. Pathology reports showed arteriolar aneurysms and arteriovenous anastomoses in the retina. Paul W. Miles.

Reynon, M., Lanot, C. and Masbernard, A. **Ophthalmologic findings in neuropsychiatry. (Study of 200 cases.)** Ann. d'ocul. **190**:17-35, Jan., 1957.

The authors studied a group of 200 young soldiers who had verified diagnoses of neurologic or psychiatric disorders. There were 35 cases of epilepsy (and its variants), 38 of chronic alcoholism and 127 of purely functional disorders. Occasionally a loss of visual acuity was seen. A few field defects were noted, but rather surprising was the finding of a lowered diastolic pressure in the central retinal artery in 75 percent of the cases. A hyperemia of the disc is also reported in 40 to 60 percent of the cases. All the findings, both subjective and objective, were reversible through shock therapy. (3 tables, 28 references) David Shoch.

Taylor, P. J. **Cavernous sinus thrombophlebitis.** Brit. J. Ophth. **41**:228-237, April, 1957.

Two cases of cavernous sinus thrombophlebitis are described and the literature is reviewed. Both cases resulted from a hordeolum and the etiologic agent was the Staphylococcus aureus. In the first patient resistance to penicillin was noted, and the second patient was remarkably resistant to all antibiotics. Intensive therapy with penicillin, anticoagulants and broad-spectrum antibiotics is recommended since the number of penicillin-resistant patients is increasing. Early blood cultures as well as studies of sensitivity to any growths are advised. (5 figures, 25 references)

Lawrence L. Garner.

19

CONGENITAL DEFORMITIES, HEREDITY

François, J. Verriest, G., de Rouck, A. and Dejean, C. **The visual functions in idiopathic hereditary night blindness.** Ophthalmologica **132**:244-257, Oct., 1956.

The principal visual functions were studied in three cases of idiopathic hereditary night blindness which were direct descendants of Jean Nougaret (cfr. Duke-Elder, Textbook of Ophth. Vol. I, p. 386).

Under photopic conditions there were no demonstrable visual anomalies. Under scotopic conditions the physiologic central scotoma was absent, the light sensitivity rose rapidly during the first three minutes of adaptation and reached a plateau after five minutes and in the electroretinogram the b-wave was missing completely. (10 figures, 1 table, 23 references) Peter C. Kronfeld.

Jablonski, W. M. **Heredity of green-blindness.** Brit. J. Ophth. **41**:186-187, March, 1957.

Marriage between members of two families in which green-blindness was present produced three green-blind males and one suspected green-blind female in the third generation and two green-blind males in the fourth generation. (1 table, 1 reference) Morris Kaplan.

Leffertstra, L. J. **The syndrome of congenital dyscephaly, hypotrichosis and cataract.** Ophthalmologica **132**:204-206, Sept., 1956.

A typical case of this syndrome is described (cfr. Am. J. Ophth. 37:322, 1954). (3 figures, 6 references)

Peter C. Kronfeld.

Manchanda, S. S., Nirankari, M. S. and Maudgal, M. C. **Tay-Sach's disease (amaurotic family idiocy).** Brit. J. Ophth. **41**:190, March, 1957.

Two cases of typical Tay-Sach's disease which is extremely rare in India are described. The cases were typical and in neither family was there evidence of consanguinity, which is strictly forbidden by Hindu custom. Morris Kaplan.

Marty, F. **The frequency curves of certain common senile and congenital alterations of the anterior segment in relation to age.** Arch. d'opht. **17**:5-37, 1957.

In an extensive monograph, complete with full bibliography, Marty has analyzed six conditions of the anterior segment in terms of age incidence; namely, arcus senilis, anterior axial embryonal cataract, pupillary membrane, Hudson-Stähli line, posterior marginal dysplasia, and white limbus girdle. He notes that in the senile conditions, as would be expected, there was a significant increase in frequency with age, whereas in the congenital condition of pupillary membrane there was a decrease in frequency with age, more pronounced after the age of 50 as a result of absorption. The frequency of embryonal cataract and white limbus girdle did not change with age. P. Thygeson.

Weekers, R., Moureau, P., Hacourt, J. and André, A. **Contribution to the cause of ametropia through a study of similar and dissimilar twins.** Arch. d'opht. **17**:38-44, 1957.

In this study the authors conclude that in identical twins hypermetropia and astigmatism are almost identical, whereas myopia, when high, can vary greatly in amount. They believe that genetic factors act exclusively in astigmatism and hypermetropia, whereas in myopia other factors not yet fully defined are dominant. They believe that identity of hypermetropia and astigmatism in twins is good evidence that the twins are identical. P. Thygeson.

20

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

De Gennaro, Giuseppe. **Ocular manifestations of industrial diseases which require reporting to the State.** Rassegna ital. d'ottal. **25**:401-464, Nov.-Dec., 1956.

This long article concerns the various ocular changes from industrial poisoning which Italian law requires. A list of 40 pathologic changes is presented. The descriptions of the more common lesions are well shown and make a valuable aid to the care and prevention of such injuries. (22 figures, 95 references) E. M. Blake.

Dejean, C. **Physiopathologic study of modern illumination.** Arch. d'opht. **16**: 697-704, 1956.

The author states that the purpose of illumination is to permit an object to be seen properly. This end is obtained if five fundamental conditions are met: 1. the size of the object must be sufficiently large; 2. there must be contrast between the object and its background; 3. sufficient time must be allowed for the eye to fixate; 4. the illumination must be sufficiently intense; and 5. the retinocerebral mechanism must be intact. These various conditions are discussed in detail. Dejean then considers the various types of electric illumination, including tungsten filament and fluorescent bulbs, and discusses the pathologic effects of illumination, with special emphasis on fluorescent lighting. He notes that with this type of lighting there is a high incidence of eyestrain among workers in factories. He attempts to analyze the reason for this in terms of ultraviolet light production and the pulsating character of the light. He notes that this pulsating effect can induce epileptic attacks and other neurologic manifestations in predisposed individuals. Neutralization of this stroboscopic effect by the use of multiple tubes is recommended. P. Thygeson.

English, P. B. **Aspects of ophthalmology in Queensland.** Tr. Ophth. Soc. Australia **16**:7, 1956.

The presidential address delivered at the sixteenth annual meeting of the Ophthalmological Society of Australia (B.M.A.) includes a brief discussion of some aspects of ophthalmology prominent in Queensland. These include blindness due to eating "finger cherries" (Rhodomyrtus macrocarpa), rodent ulcer of the eyelids, pterygium, trachoma, plumbism from verandah-rail paint occurring in nail-biting children, and glaucoma.

Ronald Lowe.

Pitt, David B. **Congenital malformations and maternal rubella.** M. J. Australia **1**:233-239, Feb., 23, 1957.

Pitt discusses the present knowledge of the teratogenic effects of rubella in pregnancy, emphasises the need for further study of this problem and criticizes the high malformation rates stated by earlier Australian authors. The author believes that the overstatements of the latter are due to faulty statistical interpretations while looseness of diagnosis may also have contributed.

A small series of cases (20) of rubella in pregnancy is reported in which the true malformation rate is similar to that observed overseas, namely between 10 and 25 percent. A larger series with more exact criteria is being organised by the Department of Obstetrics and Gynecology in the University of Melbourne. (1 figure, 6 tables, 19 references)

Ronald Lowe.

Schappert-Kimmijser, J. **The causes of blindness in blind persons living in The Hague and surrounding districts.** Ophthalmologica **132**:176-180, Sept., 1956.

The total population of the Hague including suburbs is about 692,000. In that area 370 cases of blindness are registered (definition of blindness not stated). The most frequent causes of blindness are: glaucoma (12 percent), peripheral retinal or choroidal degenerative disease (10 percent), uveitis (10 percent), injuries (8 percent), degenerative myopia (7 percent) and macular degenerations (6 percent). Peter C. Kronfeld.

Van Beek, C. J. **Three years' personal experience in Indonesia.** Ophthalmologica **132**:304-306, Nov., 1956.

On the basis of three years of personal experience (May, 1952 until May, 1955) the author describes the working and living conditions in present-day Indonesia with hardly any references to the ophthalmologic problems of the country.

Peter C. Kronfeld.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
411 Oak Street, Cincinnati 19, Ohio

News items should reach the editor by the 10th of the month. For adequate publicity, notice of postgraduate courses and meetings should be received three months in advance.

Deaths

Dr. Olney B. Monosmith, Lorain, Ohio, died March 8, 1957, aged 85 years.

Announcements

American Optical seminar

An intensive course in visual optics and refraction for ophthalmologists, and a seminar on aniseikonia will be given by members of the staff of the Bureau of Visual Science at the American Optical Company in Southbridge, Massachusetts. First to be held will be the seminar on aniseikonia, on October 7th, 8th, and 9th. The conference in visual optics and refraction will be held on November 11th, 12th, and 13th.

The fifth educational conference in visual optics and refraction for ophthalmologists will provide intensive coverage of a broader range of topics of interest to the doctor. Some of the topics will be basic concepts in ophthalmic optics, objective refractive tests, physiologic methods of determining multifocal corrections, and monoplex eyes and implants.

Guest lecturers from the medical profession will join the Bureau of Visual Science staff to present lectures and demonstrations on the correction of subnormal vision and on indirect ophthalmoscopy. There will also be field trips through American Optical lens and frame manufacturing plants and the research center.

John Crerar library

The John Crerar Library, 86 East Randolph Street, Chicago 1, Illinois, reports that the Special Libraries Association Translations Center is maintained as a co-operative effort to make more widely available the results of translation work being done by industry, government, and private agencies and individuals. Under a grant from the National Science Foundation, it will now be possible to merge the collections of translations which have been previously maintained separately by the Library of Congress and the Special Libraries Association into one center at Crerar Library.

It is expected that soon a small brochure describing the Special Libraries Association Translation Center will be issued. *Translation Monthly* will be published as a reporting service to inform interested researchers of the translations which are available.

Service to the blind

Opportunities for graduate level preparation in professional service to the blind are being made available by the Industrial Home for the Blind in Brooklyn, New York, with the co-operation of the Office of Vocational Rehabilitation. The program of preparation, lasting 20 or 40 weeks, depending upon the needs of the individual student, accepts a limited number of students each fall and spring for preparation as psychologists, vocational counselors, vocational placement specialists, foot-travel instructors, vocational instructors, supervisors of sheltered workshops, vending-stand supervisors, home teachers, administrators of vocational programs, and workers with the deaf-blind.

For further information and application blanks, write to:

Dr. Herbert Rusalem
Director, Professional Training Department
Industrial Home for the Blind
57 Willoughby Street
Brooklyn 1, New York.

Entrance requirements include a bachelor's degree, a high degree of professional promise, and outstanding personal and professional competency.

Seminar on glaucoma

A seminar on glaucoma with particular emphasis on gonioscopy and the study of the anterior angle will be given at the Brooklyn Eye and Ear Hospital on November 18th, 19th, and 20th. Ample opportunity for practical instruction in the use of the gonioprism will be given and material from the glaucoma clinic will be utilized.

The course will be given by Dr. Daniel Kravitz, assisted by Dr. Mortimer A. Lasky, Dr. A. Benedict Rizzuti, Dr. Abner S. Rosenberg, Dr. Nicholas P. Tantillo, and Dr. Samuel Zane.

Registration is limited to six ophthalmologists only.

Application and the fee of $50.00 may be addressed to:

Dr. Daniel Kravitz
Brooklyn Eye and Ear Hospital
29 Greene Avenue
Brooklyn 38, New York.

Asia-Pacific tour

The Asia-Pacific Academy of Ophthalmology is sponsoring a good-will tour to countries of the Orient following the International Congress of Ophthalmology in Brussels in September, 1958. The purpose of this tour, which is to last approximately one month, is to hold joint meetings with ophthalmologists in Pakistan, India, Burma, Thailand, the Philippines, Hong Kong, and Japan. It is expected that this good-will tour will create much interest

among ophthalmologists in the countries to be visited and contribute greatly to American-Asiatic medical rapprochment.

The United States government has given its wholehearted support to the plan of stimulating and facilitating a continuing exchange of information and techniques, treatments, and devices for the care of the ill and the blind.

The reception of a group of ophthalmologists the world over will certainly be most cordial and will assure the success of this enterprise.

The ophthalmologic material in all the countries is extremely interesting and should be of great value to members of the tour.

Further information regarding the itinerary and the exact dates of this good-will trip will be announced later. In the meantime, additional information may be obtained by writing to:

Liaison Secretary
Asia-Pacific Academy of Ophthalmology
Suite 280, Alexander Young Building
Honolulu 13, Hawaii.

Post-Graduate school courses

New York University Post-Graduate Medical School offers the following courses:

Ocular expressions of systemic disease, a part time course of five days' duration, 9:00 A.M. to 12:00 M., September 16 through 20, 1957, given under the direction of Dr. Isadore Givner. This course is given primarily to show the representations in the eye of systemic disease. Not only are clinical aspects discussed, but also the histopathologic findings where indicated. Tuition: $55.00.

Histopathology, a part-time course of five days' duration, 1:00 to 4:00 P.M., September 16 through 20, 1957, given under the direction of Dr. A. Marvin Gillman. This is designed to review the basic principles of ocular disease and to investigate the many individual ocular diseases in terms of a relatively few basic pathologic patterns. The course consists of lectures, demonstrations, and individual laboratory study of basic pathologic patterns as exemplified by the most important specific inflammatory, neoplastic, traumatic, metabolic, and physiologic conditions seen in ophthalmology. Tuition $100.00.

For further information write to:

The Dean
Post-Graduate Medical School
550 First Avenue
New York 16, New York.

Military ophthalmologists

The Society of Military Ophthalmologists and the Society of Military Otolaryngologists will hold their annual joint dinner meeting during the meeting of the American Academy of Ophthalmology and Otolaryngology in Chicago in October.

Cocktails and dinner will be served in the private dining rooms of the Palmer House Hotel at 6:30 P.M. on Tuesday, October 13th. All members, ophthalmologists and otolaryngologists on active duty, or retired, are invited to attend.

Reservations may be made at the time of registration for the Academy convention. Other information may be obtained from:

Maj. Stanley H. Bear
3810th USAF Hospital
Maxwell Air Force Base, Alabama.

Societies

Cleveland officers

At the last meeting of the Cleveland Ophthalmological Club the following officers were elected:

President, Dr. Thayer L. Parry; president elect, Dr. S. T. Forsythe; vice-president, Dr. William H. Evans; secretary-treasurer, Dr. Herman C. Weinberg; assistant secretary-treasurer, Dr. Robert C. Kirk.

Personals

Dr. Edward J. Donnelly has been appointed attending surgeon at Wills Eye Hospitals, Philadelphia. He has been a member of the staff for 25 years. Dr. Donnelly is also active consultant in ophthalmology, St. Vincent's Hospital and Philadelphia General Hospital, and assistant professor of clinical ophthalmology, Jefferson Medical College.



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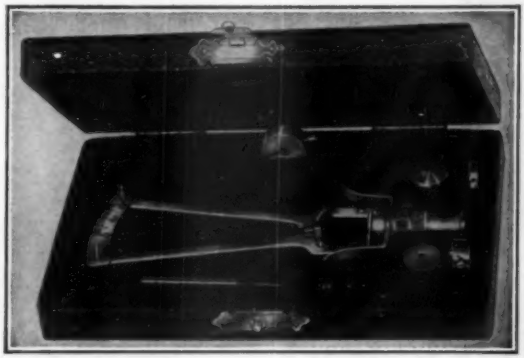
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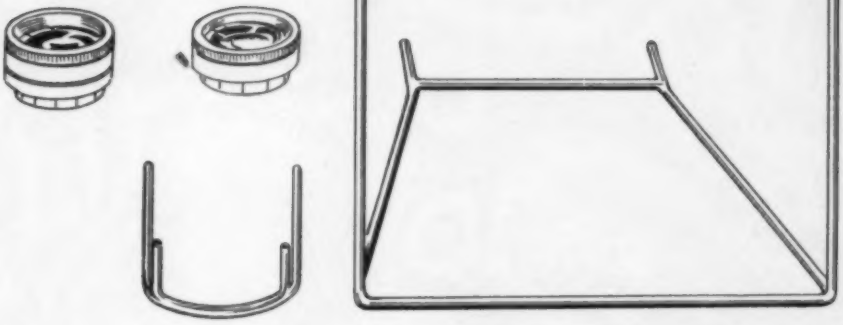
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